POST-TRAUMATIC STRESS DISORDER (PTSD) AMONG WOMEN LIVING WITH HIV: AN EXAMINATION OF CONTEXT, CHANGE, AND EFFECT ON HIV OUTCOMES

by

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Abstract

Statement of problem or theory: This dissertation focuses on posttraumatic stress disorder (PTSD) among U.S. women living with HIV. There is a high prevalence of recent PTSD in this population (30%), yet little is known about its characteristics, change over time, and relationship to HIV care outcomes. PTSD may itself negatively affect HIV care outcomes.

Methods: I used data from 1,098 women living with HIV across the US who were participating in an ongoing longitudinal cohort study and provided data on severity of their PTSD symptoms. Conceptualizing PTSD as a latent variable, I applied latent variable methods (latent class analysis, latent class regression, and latent transition analysis) to group participants by PTSD symptom severity and patterns, examine associated sociodemographic and psychosocial characteristics, explore HIV outcomes over time associated with latent class membership, and investigate change in PTSD over time.

Results: Participants had a low overall socioeconomic status and high prevalence of lifetime violence experience with 54.7% having experienced severe physical abuse, 42.1% having experienced sexual assault, and 38.9% experiencing psychological abuse. Over one-fifth (21.3%) experienced all three types of abuse. Latent class analysis results supported a model where participants were split into three groups – high, medium, and low severity - differing only by PTSD symptom severity and not by symptom pattern or configuration. Socioeconomic status and violence experience differentiated PTSD latent classes. Specifically, sociodemographic characteristics associated with membership in the high or medium class included race, country of birth, employment, education, housing, sexual identity, and income. Those in the high or medium classes were more likely to have experienced violence, and those in the high severity

class were more likely to have experienced recent violence. Participants in the high or medium PTSD severity class had poorer medication adherence and worse HIV outcomes (less likely to have an undetectable viral load, more likely to have a CD4 count consistent with AIDS). However, medication adherence explained the differences in detectable viral load and CD4 counts consistent with an AIDS diagnosis between PTSD classes. Examining PTSD latent class stability, I found that latent class membership changed over time with a higher proportion of participants moving to a higher disturbance class than to a lower disturbance class. These changes were predicted by demographic characteristics, prior violence experience, and economic hardship. In particular, participants whose PTSD symptoms appeared between the baseline and time 1 were more likely to be of Hispanic ethnicity; bisexual, lesbian/gay or other (non-heterosexual) orientation; unemployed; have less than a high school education; have experienced physical assault, particularly by a family member; and have experienced psychological abuse from a partner. Participants whose PTSD symptoms were maintained or worsened were more likely than their counterparts to have experienced sexual assault before the age of 18. Participants who recovered from PTSD during this study were more likely to be employed, less likely to have a low income, and less likely to have been sexually assaulted before the age of 18.

Conclusions: Women living with both PTSD and HIV conditions are suffer disproportionately from past or ongoing experiences of violence and trauma coupled with low socioeconomic status including unemployment, low educational attainment, low income, and unstable housing. Programs that address HIV should not only be trauma-informed and incorporate mental health treatment but also respond to patients' or clients' basic needs, such as housing and employment. The results of this research also point to several important, future research questions to further characterize PTSD among WLHIV, as well as address PTSD. These areas of inquiry include how

PTSD manifests among other populations living with HIV, such as youth or non-heterosexual individuals; the role of medication adherence in the pathway between trauma and poor HIV outcomes; effective PTSD treatment modalities tailored to WLHIV; and evaluating PTSD and HIV outcomes within programs that can incorporate HIV care, mental health treatment, and social services.

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"There will be struggles — I've certainly had my share of struggles. But here's what I want you to know: You're not supposed to go through this on your own. No one gets through college or life on their own. So when you hit those walls — and you will — don't be surprised, don't be shocked, don't think it's you, don't think you're not supposed to be there. Go get some help. Don't sit in your room alone. Do not stew or stir. Go out and build your base of support. You cannot do this alone — I didn't, and we are not expecting that from any one of you. Y'all can get this done. If I can do it, you can do it."

-Michelle Obama

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Contents

List of Acronyms and Abbreviations

AIC	Akaike Information Criterion
BIC	Bayesian Information Criterion
AIDS	Acquired Immunodeficiency Syndrome
ART	Antiretroviral therapy
ASO	AIDS service organization
CAPS	Clinician-Administered PTSD Scale
CBO	Community-Based Organization
CDC	Centers for Disease Control and Prevention
CI	Confidence interval
cPTSD	Complex Posttraumatic Stress Disorder
DSM	Diagnostic and Statistical Manual
HHS	Health and Human Services (Federal Agency in Executive Branch)
HIV	Human Immunodeficiency Virus
IPV	Intimate Partner Violence
LCA	Latent class analysis
LCR	Latent class regression
LEC	Life Events Checklist
LTA	Latent transition analysis
LRC	Linkage and Retention in Care
LRT	Likelihood Ratio Test
MICE	Multiple imputation by chained equations
NHAS	National HIV and AIDS Strategy
ONAP	Office of National HIV and AIDS Programs
OR	Odds ratio
PCL-C	Posttraumatic Checklist-Civilian Version
PLWH	People living with HIV
PTSD	Post-traumatic Stress Disorder
RR	Risk ratio
SAMHSA	Substance Abuse and Mental Health Services Administration
SD	Standard deviation
SES	Socioeconomic Status
STD	Sexually transmitted disease
STI	Sexually transmitted infection
VL	Viral load
WIHS	Women's Interagency HIV Study
WLHIV	Women living with HIV

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Introduction

Background

HIV Care Outcomes among U.S. Women

Out of the nearly 230,000 women living with HIV (WLHIV) in the U.S., 50% are not adequately engaged in ongoing, primary HIV care and 52% do not have a suppressed viral load (Centers for Disease Control and Prevention, 2017b). Inadequate engagement in care limits access to antiretroviral therapy and decreases viral suppression (Del Romero, Castilla, Hernando, Rodríguez, & García, 2010; Donnell et al., 2010). Suppressed viral load, or a viral load that is lower than 200 RNA copies per mL, indicates that the virus is controlled and is associated with decreased morbidity, decreased mortality, and a lower probability of transmitting HIV. Individuals with suppressed viral loads also have a low probability of transmitting HIV and being in care is associated with lowered HIV risk behaviors (M. S. Cohen et al., 2011; Metsch et al., 2008). Understanding poor HIV care outcomes among U.S. women is of great public health importance as the number of WLHIV continues to grow.

Women account for 20% of new HIV cases and 25% of AIDS cases (Centers for Disease Control and Prevention, 2014a). Also, there are alarming disparities in new HIV cases: 64% were among African-American women, and 15% were among Latina/Hispanic women (Centers for Disease Control and Prevention, 2014a). African-American women have the fourth highest HIV incidence of all risk groups (Centers for Disease Control and Prevention, 2015a). In the Southeastern U.S., HIV-related mortality is higher among women than men (S. S. Reif, Safley, Wilson, & Whetten, 2016). Risk factors for poor HIV outcomes (engagement in care, treatment adherence, and viral suppression) among women include poverty, substance use, poor mental health, number and type of traumatic events, lack of transportation, long distances to care

providers, cost of care, and placing the needs of their family members above their own (Blank et al., 2015; Boehme et al., 2013; Centers for Disease Control and Prevention, 2015; Espino et al., 2015; Khanna, 2012; Moneyham et al., 2010; K. A. Sullivan, Messer, & Quinlivan, 2015). While many of these issues apply to all individuals living with HIV, the role of trauma is particularly salient for WLHIV and explored in this dissertation.

Previously, the United States articulated policy goals to address the epidemic. These goals are described in the Updated 2015-2020 National HIV/AIDS Strategy (NHAS). The updated National HIV/AIDS Strategy's Goal 2 is "Increasing Access to Care and Improving Health Outcomes for People Living with HIV" and calls for "Improving outcomes at every step of the HIV care continuum" and "Developing models of competent care that treat the whole person, as well as the virus".[1] Goal 3 of the NHAS is "Reducing HIV-related Health Disparities and Health Inequities". Populations highlighted for Goal 3 that are addressed here are "Black women and persons living in the Southern United States (ONAP, 2015)." Findings from this dissertation inform interventions designed to improve health outcomes for people living with HIV by providing information relevant for clinicians and those designing linkage and retention to care program. This dissertation also provides detailed information about the “whole person” living with HIV and PTSD, which will aid in developing care models to address the needs of this population. Also, given that the population that this dissertation focuses on is women living with HIV the majority of whom are African-American, the findings present here will provide important information for meeting Goal 3.

[1] The HIV continuum of care is a widely used way to summarize HIV care outcomes in an area (Gardner, McLees, Steiner, Del Rio, & Burman, 2011). It includes HIV diagnosis, linkage to care, retention in care, provision of antiretroviral therapy (ART), and viral suppression (Centers for Disease Control and Prevention, 2014b). The definitions for each individual indicator may vary based on context and available data.

Traumatic events

Trauma has been defined as “an emotional response to an event like an accident, rape, or natural disaster” (American Psychological Association, 2016). Some of the traumatic events known to be associated with later development of PTSD include physical assault; sexual assault; other unwanted or uncomfortable sexual experience; captivity; life-threatening illness or injury; sudden and violent death (e.g., homicide, suicide). There are other events in common trauma screening measures, and the life events checklist (LEC) even includes "any other very stressful event or experience" named by the participant (F.W. Weathers et al., 2016). One study that focused on U.S. women found that greater lifetime exposure to violence (witnessed or experienced) was associated with major depressive episodes, manic or hypomanic episode, posttraumatic stress disorder, social phobia, and general anxiety disorder (Cavanaugh, Martins, Petras, & Campbell, 2013). Broad, international surveys have found associations between trauma exposure, particularly sexual and interpersonal violence, and suicidal behaviors (D. J. Stein et al., 2010).

Trauma exposure underlies many of the leading causes of morbidity, mortality, and health risk behavior in the US. Trauma influences alcoholism, drug abuse, depression, suicide attempts, smoking, number of sexual partners, and sexually transmitted infections (Felitti & Anda, 2010; Felitti et al., 1998) and predicts poorer HIV care outcomes (Cohen et al., 2004; Hatcher, Smout, Turan, Christofides, & Stoeckl, 2015; Leserman et al., 2005; Lichtenstein, 2006; M. J. Mugavero et al., 2009; M. Mugavero et al., 2006; Schafer et al., 2012), which is what this dissertation explores.

Post-Traumatic Stress Disorder

Post-traumatic stress disorder (PTSD) is a trauma-related psychological disorder resulting from at least one of a group of traumatic events described in the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2013a). Its symptoms are grouped into re-experiencing symptoms, avoidance, negative affect and mood, and hyperarousal (American Psychiatric Association, 2013a). These groups are often referred to as "clusters". Direct experience of assaultive violence leads to PTSD more often than any other type of traumatic event, and PTSD affects women more often than men despite higher incidence of traumatic experiences among men (N Breslau, Chilcaot, Kessler, Peterson, & Lucia, 1999; N Breslau, Chilcoat, Kessler, & Davis, 1999; Gill, Page, Sharps, & Campbell, 2008; White et al., 2015). Earlier age at trauma is also associated with developing future PTSD (N Breslau, Chilcoat, et al., 1999).

Several factors have been identified as protective (resilience, social support) and increasing susceptibility (prior trauma, lack of social support following trauma) (Brewin, Andrews, & Valentine, 2000; Javidi & Yadollahie, 2012). Social support, in particular, has been identified as important for women with HIV when compared to men living with the illness (Rzeszutek, Oniszczenko, & Firląg-Burkacka, 2017). PTSD becomes chronic for many. A study based on a large, nationally representative sample found that over one-third of PTSD cases persisted for many years (Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995a).

In the Diagnostic and Statistical Manual (DSM-IV) [2], PTSD includes 17 symptoms (Table 24), which are organized into three symptom clusters: B) re-experiencing, C) avoidance

[2] The latest DSM (DSM-V) has updated PTSD to include four symptom clusters and 20 symptoms (American Psychiatric Association, 2013a), but the. The four symptom clusters are

and numbing, and D) hyperarousal (Criterion A specifies stressors that may lead to PTSD and is not described in detail as this dissertation focuses on PTSD symptom severity rather than underlying traumatic event). While symptoms from each cluster are criteria for a PTSD diagnosis, the relative intensity of each symptom cluster has been shown to be differentially related to outcomes such as HIV/STI risk behavior, sexual re-victimization, and substance use particularly the avoidance and numbing cluster (Cavanaugh, Hansen, & Sullivan, 2010; Krause, Kaltman, Goodman, & Dutton, 2006; Overstreet, Willie, Hellmuth, & Sullivan, 2015; Risser, Hetzel-Riggin, Thomsen, & McCanne, 2006; T. P. Sullivan & Holt, 2008).

Avoidance and numbing refers to the avoidance of memories, thoughts, or feelings related to traumatic events, as well as numbing behaviors. Hyperarousal is characterized by hypervigilance and sleep disturbances (American Psychiatric Association, 2000). Avoidance and numbing symptomatology are linked to substance use and riskier sexual behaviors while hyperarousal may decrease sexual risk behaviors but limit trust in healthcare providers that may in turn lead to poorer care outcomes (Cavanaugh et al., 2010; Overstreet et al., 2015). Among large, community-based samples, avoidance and numbing symptom severity also differentiates latent classes of PTSD symptom severity (Naomi Breslau, Reboussin, Anthony, & Storr, 2005). Subthreshold PTSD, or PTSD symptoms that do not rise to the level of a diagnosis, have also

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avoidance, negative alterations in cognition and mood, hyperarousal, and re-experiencing. The symptom clusters and measurement scale used in this research are based on criteria from the previous version (DSM-IV) due to their inclusion in 2008 in an ongoing, longitudinal cohort study that is the "parent study" for this dissertation (American Psychiatric Association, 2000).(American Psychiatric Association, 2000). Despite the change, use of the DSM-IV is preferable as the vast majority of available literature uses the DSM-IV definition. Furthermore, the PCL instrument corresponding with the updated DSM (DSM-V) asks about one specific traumatic event, rather than "a" or any traumatic event. Given that many individuals in this population may have experienced multiple traumatic events, or ongoing trauma, the PCL-C is preferable to the newer instrument.

been associated with significant impairment (Cukor, Wyka, Jayasinghe, & Difede, 2010; M. B. Stein, Walker, Hazen, & Forde, 1997). Due to differences in health outcomes related to varying manifestations of PTSD, it is important to examine PTSD not only by its presence or absence, but also by the intensity of its symptoms. PTSD must also be examined by the different types of symptoms that are present. Previous work examining PTSD among PLWH largely conceptualizes PTSD as present or absent, does not examine subthreshold PTSD, and does not differentiate by different symptom clusters.

The concept and study of PTSD has begun relatively recently and arose in response to the phenomenon of "shellshock" arising among military personnel. Examining PTSD among women is a topic, in particular, where study has begun much more recently. In her authoritative text, *Trauma and Recovery*, Dr. Judith Herman argues that sexual and domestic violence, which are often perpetrated against women, can occur only in a society questioning the validity of oppressing women and children. Hence, for there to be support and recognition for any research examining the effects of trauma due to violence against women, society must recognize this as a crime or violent act. Prior to this recognition, PTSD among women as a result of assaultive violence was not studied; in fact, early work on childhood sexual assault by Sigmund Freud was retracted due to resistance from his contemporaries (Herman, 1997).

PTSD prevalence and risk factors

According to the National Comorbidity Survey, the lifetime prevalence of PTSD among U.S. adults is 6.8%, and 3.6% of adults had PTSD in the past year. Women were more affected by PTSD: 5.2% of women had PTSD in the past year compared to only 1.8% of men (Harvard

Medical School, 2005). Other previous studies have found that women are more likely than men to develop PTSD following trauma at various points in the life course (N Breslau, Chilcoat, et al., 1999; Walker, Carey, Mohr, Stein, & Seedat, 2004). In particular, impoverished women living in urban areas have a high reported prevalence of PTSD. One study in Baltimore found that 13.8% of women had PTSD symptoms compared with 11.3% of men, and that White women living below 125% of the poverty line were most likely to have PTSD symptoms when compared to other gender and racial groups (Parto, Evans, & Zonderman, 2011). Other studies have shown that neighborhood context to be associated with PTSD (Latkin, Curry, Hua, & Davey, 2007). Racial and ethnic minority groups also experience PTSD at higher rates than White individuals. A study representing the U.S. population found higher rates among Black/African-Americans (8.7%) compared to Whites (7.4%), Hispanics (7.0%), and Asians (4.0%). These patterns held when controlling for trauma exposure, and all minority groups were less likely to seek care for PTSD when compared to Whites (A. L. Roberts, Gilman, Breslau, Breslau, & Koenen, 2011). Recent studies also suggest that economic vulnerability may contribute to the persistence of PTSD (Golin et al., 2016).

PTSD is significantly more common among PLWH, especially women, than the general US population (E. L. Machtinger, Wilson, Haberer, & Weiss, 2012). Among women living with HIV, approximately 30% have recent PTSD (E. L. Machtinger et al., 2012). In addition, both HIV and PTSD particularly affect U.S. communities of color. Despite the significance and severity of this problem, little is known about the individual and contextual factors affecting WLHIV and PTSD. Recent reviews have called for increased investigation in this area, and this dissertation responds to this gap by quantitatively examining sociodemographic factors and comorbidities WLHIV who have PTSD (LeGrand et al., 2015). Among individuals with PTSD,

depression and substance use disorders are common comorbidities (Jaquier, Flanagan, & Sullivan, 2015; Smith, Smith, Cercone, McKee, & Homish, 2016). PTSD is also associated with increased sexual risk behavior, HIV, STIs, cardiovascular disease, sexual revictimization, obesity, insomnia, and medication non-adherence (Brown & Mellman, 2014; A. Duncan et al., 2015; Edmondson & Cohen, 2013; El-Bassel, Gilbert, Vinocur, Chang, & Wu, 2011; Green et al., 2005; Houston, Sandfort, Watson, & Caton, 2013; Hutton et al., 2001; Kronish, Edmondson, Li, & Cohen, 2012; Overstreet et al., 2015; Pearson et al., 2015; Plotzker, Metzger, & Holmes, 2007; Risser et al., 2006; Sumner et al., 2015; Weiss, Tull, & Gratz, 2014).

Trauma and HIV Care outcomes

A higher number of lifetime traumatic events is associated with an increased risk of death among individuals living with HIV (Leserman et al., 2007). Among WLHIV, traumatic events are associated with poorer HIV care outcomes, including decreased medication adherence, increased mortality, and higher viral load (Leserman et al., 2007; M. J. Mugavero et al., 2009). There are two specific linkages between trauma and HIV that have been explored in depth. The first is the relationship between intimate partner violence (IPV) and HIV risk (Breiding, Black, & Ryan, 2008; Cavanaugh et al., 2010; González-Guarda, Peragallo, Urrutia, Vasquez, & Mitrani, 2008; Overstreet et al., 2015). The second area of research that has been examined in depth is IPV and diminished ability to progress through the continuum of care (M. H. Cohen et al., 2004; Hatcher et al., 2015; Leserman et al., 2005; Lichtenstein, 2006; M. Mugavero et al., 2006; M. J. Mugavero et al., 2009; Schafer et al., 2012; Ulett et al., 2009). Other traumatic events, such as childhood sexual assault, are also associated with HIV incidence and poor progression through the HIV care continuum (Cohen et al., 2004; Hatcher et al., 2015; Leserman et al., 2005;

Lichtenstein, 2006; Schafer et al., 2012). Few studies examine the links between multiple forms of abuse common among WLHIV and HIV care outcomes (provision of ART, suppressed viral load), which this dissertation examines (M. J. Mugavero et al., 2009).

PTSD and HIV Care outcomes

PTSD, in and of itself, may negatively affect HIV. Several studies have found an association between PTSD and HIV behaviors and care outcomes. Specifically, PTSD has been associated with decreased medication adherence, increased disease progression, and decreased CD4 counts suggesting that the effects of trauma may be operating through PTSD on HIV (Boarts, Sledjeski, Bogart, & Delahanty, 2006; Delahanty, Bogart, & Figler, 2004; Pantalone, Hessler, & Simoni, 2010; Reilly, Clark, Schmidt, Benight, & Kissinger, 2009). However, other studies did not find a relationship between PTSD and HIV outcomes (Sledjeski, Delahanty, & Bogart, 2005; Vranceanu et al., 2008). A recent review suggested that these contradictory results were due to the use of a brief PTSD screening instrument or limiting symptom measurement to the previous week (Blashill, Perry, & Safren, 2011). To address this ambiguity in the literature, this dissertation uses an instrument with one item devoted to each symptom that has strong psychometrics, the Posttraumatic Checklist-Civilian Version.

Depression is also highly comorbid with HIV (up to 36%) (Bing et al., 2001), and may lead to high viral loads and poor medication adherence (Bottonari, Safren, McQuaid, Hsiao, & Roberts, 2010; Carrico et al., 2011; Gonzalez et al., 2011; Ickovics et al., 2001; Leserman, 2008; Mellins et al., 2009). However, a recent randomized controlled trial (RCT) suggests no effect of addressing depression: treating depression through medication did not improve medication adherence and HIV outcomes (Brian W Pence et al., 2015). Furthermore, several previous

studies show depression to stem from PTSD (Aderka, Foa, Applebaum, Shafran, & Gilboa-Schechtman, 2011; Aderka, Gillihan, McLean, & Foa, 2013; Liverant, Suvak, Pineles, & Resick, 2012; McLean, Su, Carpenter, & Foa, 2015). Given the findings of these studies, it is plausible that not addressing PTSD among people living with HIV may lead to poor HIV care outcomes. To continue this line of inquiry and enhance the evidence base for HIV programs, this dissertation focuses on the role of PTSD in HIV.

Review of previous programs to address PTSD among PLWH

Despite the increasing calls for programs addressing trauma and PTSD for people living with and at-risk for HIV, there are few randomized studies describing interventions to address PTSD among PLWH (Applebaum et al., 2015). One intervention among 24 substance abusing WLHIV found a reduction in PTSD symptoms, but >30% of intervention participants dropped out (vs. 0% of control participants) (Pacella et al., 2012). Another intervention (n=161 women) focused on women with past childhood sexual assault and found reductions in substance use and PTSD symptoms (intrusion and avoidance). Hence, these findings are not generalizable to all WLHIV and PTSD, but represent a promising approach (Sikkema et al., 2013). In addition, neither examined improvements in HIV medication adherence or outcomes. These interventions were both cognitive-behavioral therapy (CBT) approaches; yet, trauma therapists emphasize the importance of other modalities, such as somatic techniques and EMDR (van der Kolk, 2014). Indeed, a recent study found individuals with PTSD (but not necessarily individuals living with HIV) to prefer interpersonal psychotherapy, and for those with comorbid depression, using a preferred modality was associated with reduction in PTSD symptoms (Markowitz et al., 2016). A randomized community-based intervention addressing HIV-positive women with histories of

violence, called the Healing Our Women Project, achieved a reduction in PTSD symptoms and psychological distress. It did not use CBT-based methodologies, but a gender and community-specific 11-session intervention (Wyatt et al., 2011).

Beyond these three randomized studies, there have been five other intervention studies. These primarily took place in AIDS service organizations or HIV clinics, and in four of these studies, loss to follow-up was over 30%. Only two focused exclusively on women (Bernstein et al., 2012; M. H. Cohen et al., 2011; Hansen et al., 2006; Ironson et al., 2013; Williams et al., 2013). Seeking Safety, a CBT-based intervention to address PTSD and substance use disorder simultaneously, was tested among transgender women living with HIV. Participants' (n=7) PTSD symptom scores decreased by 17.5% (Empson et al., 2017). This section provides a brief overview of interventions to address PTSD among individuals living with HIV. Few studies exist, particularly those with rigorous designs. Of those that do, CBT is the main PTSD treatment modality, but there are many other evidence-based treatments available. Also, few studies measure both PTSD and HIV outcomes. This area of research is nascent but growing, and the results of this dissertation will provide valuable insights for further inquiry (Senn, Braksmajer, Urban, Coury-Doniger, & Carey, 2017).

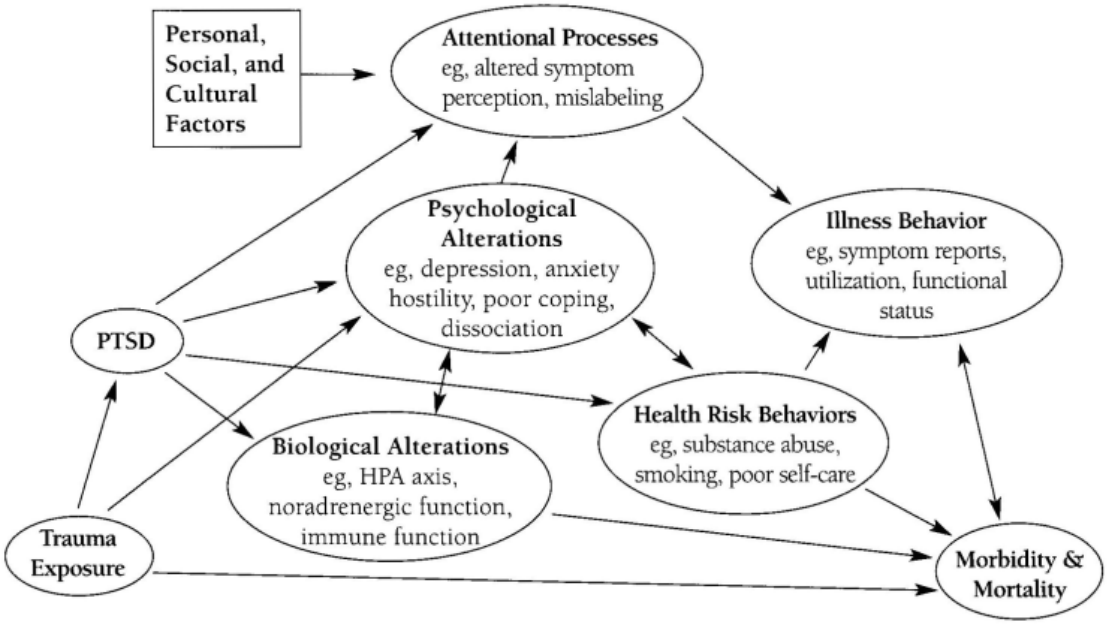
Theoretical Foundation

Dr. Sandro Galea's work examining the social determinants of mental health emphasizes the importance of social processes. Similar to the socioecological model, Galea's approach incorporates multiple levels ranging from macrosocial processes, individual behaviors, and molecular factors (Centers for Disease Control and Prevention, 2016). Among individual factors, Galea describes the importance of race and ethnicity as studies consistently find minorities to

have poorer health than their majority counterparts. Violence is described as a social factor for which the links to mental illness are well-explored. Galea also describes the importance of urban and neighborhood environment in influencing mental health (Cottler, 2011). This dissertation follows Galea's perspective. It responds to his call for a recognition of multilevel influences on mental health similar to those described in the socioecological model and includes an exploration of individual and contextual factors that differ among women with increasingly severe levels of PTSD (Aim 1). It also examines the role of many social factors (e.g., violence, income, housing status), specifically, in mental health outcomes (i.e., PTSD) throughout.

Other scientists argue that PTSD is a key mechanism through which the effects of trauma get "under the skin" (Wolf & Schnurr, 2016). Not all individuals experiencing trauma develop PTSD, which is associated with a host of behavioral and biological disturbances. This association points to the role of the response to trauma in developing future, poor health outcomes. In Schnurr's framework, the pathways from PTSD to poor health outcomes include attentional processes, psychological alterations, biological alterations, and health risk behaviors. In this model, personal, social, and cultural factors also play a role (Schnurr & Green, 2004).

1: Figure - Schnurr and Green's Model Describing Pathways between PTSD and poor physical health outcomes

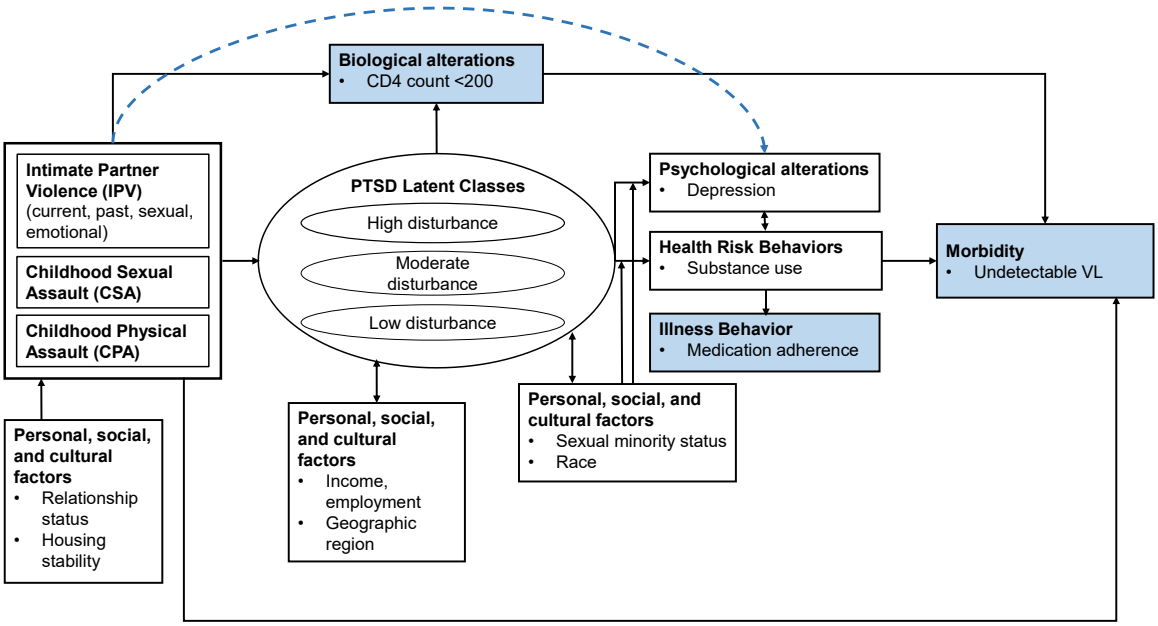


Psychological alterations may lead to behaviors, such as avoidance, that negatively impact health care-seeking and adherence. Biological alterations, such as immune function, may play a role in response to medication. Health risk behaviors, such as substance use, have been shown to be associated with poor HIV care outcomes in particular (Lucas, Gebo, Chaisson, & Moore, 2002). This research includes not only PTSD by its separate symptom clusters and HIV outcomes that measure physical health, but also health risk behaviors (substance use), psychological alterations (depression) and social and cultural factors (crime rate, relationship status, homelessness, race, income) that relate to PTSD and HIV (Alim, Charney, & Mellman, 2006; Gapen et al., 2011; Golin et al., 2016; Hartzell, Janke, & Weintrob, 2008; Heckman et al., 1998; Kessler et al., 1995a; Latkin et al., 2007; Lucas et al., 2002; Parto et al., 2011; Wolitski et al., 2010). The work of Galea describing the roots of poor mental health and Schnurr's on the effects of poor mental health on physical health drove the selection of variables and design of models tested here.

Conceptual framework

The conceptual framework below illustrates the hypothesized relationship between traumatic events, poor HIV care outcomes, and post-traumatic stress symptoms. It is based on the Schnurr and Green model but incorporates personal, social, and cultural factors into the model in the specific places where each is implicated using Galea's work. Each aim is included within the diagram, and each component is described below.

2: Figure - Conceptual model illustrating aims and relationships between trauma, PTSD, and HIV care outcomes



Traumatic events: This framework illustrates index traumatic events (intimate partner violence in the past or present, childhood sexual assault, and childhood physical assault) that have been documented to be associated with post-traumatic stress disorder and are measured in the parent study (American Psychiatric Association, 2000, 2013a).

Traumatic stress-related sequelae: Arrows represent the association between the index traumatic events and PTSD, which is shown separated into its symptom clusters.

HIV care outcomes: The shaded boxes above (biological alterations, illness behavior, and morbidity) represent the HIV care outcomes that are examined in this dissertation.

Study rationale

Several gaps exist in research on the relationship between traumatic events, post-traumatic stress, and HIV care outcomes. First, while many studies have established the link between trauma and poor HIV care outcomes, the pathways and specific mediators linking trauma and HIV outcomes are not well-understood (Applebaum et al., 2015). Also, few studies examine the relationship between PTSD and HIV care outcomes. Among those that do, very few are longitudinal, and there is variability in the way PTSD is measured. There are also methodological shortcomings such as PTSD measurement tools with low sensitivity.

Given the high prevalence of comorbid PTSD and HIV, PTSD appears to be an important psychiatric disorder to examine in the context of HIV particularly as newer studies suggest that PTSD and HIV do not simply co-exist in one individual; instead, each condition may exacerbate the other (Neigh, Rhodes, Valdez, & Jovanovic, 2015). Previous studies have not examined patterns in the manifestation of PTSD symptoms among WLHIV as have been done for community samples and often conceptualize PTSD as present or absent. Earlier work on PTSD has shown that subthreshold PTSD is associated with significant impairment and that different PTSD symptom groups are related to distinct health behaviors (Overstreet et al., 2015; M. B. Stein et al., 1997). In addition, little is known about the individual and contextual factors of

women living with HIV and PTSD, and these are key factors in shaping any future interventions designed to address PTSD and HIV outcomes (Applebaum et al., 2015).

Taken together, these gaps illustrate important future research directions towards understanding the relationship between traumatic events and the HIV care outcomes as well as the nature and context of PTSD among WLHIV. Researchers and policymakers are increasingly calling for this evidence (Applebaum et al., 2015; Interagency Federal Working Group Report, 2013; ONAP, 2015). This research responds to calls to elucidate the complex relationships between traumatic events and poor HIV outcomes; explores the unique role of each PTSD symptom cluster; and examines the relationships between PTSD and HIV care outcomes longitudinally among a large cohort of women (LeGrand et al., 2015).

The insights derived from this study can inform developing evidence-based, trauma-informed care programs for individuals living with, and at risk of, HIV (Hien et al., 2010; LeGrand et al., 2015). Understanding the psychosocial and sociodemographic factors associated with HIV and PTSD will be critical for designing future interventions appropriate to this population and the settings in which programs take place, which are largely community-based organizations. HIV care outcomes among US women are very poor as of 2014: the majority of women living with HIV were not retained in care nor had a suppressed viral load (Centers for Disease Control and Prevention, 2017b). Critical work remains to end this epidemic among U.S. women, and an important step towards ending HIV is appropriately addressing the role of trauma (Brezing, Ferrara, & Freudenreich, 2015; Edward L Machtinger, Cuca, Khanna, Rose, & Kimberg, 2015). This research also responds to the updated National HIV/AIDS Strategy's Step 2: "*Improve outcomes for women in HIV care by addressing violence and trauma*" (emphasis added; ONAP, 2015).

This research is important for the health of U.S. citizens in addition to those living with HIV: there is a great deal of literature linking traumatic events to poor health outcomes across a variety of populations (veterans, nurses, etc.) (Felitti & Anda, 2010; Sumner et al., 2015), but while the associations are well-documented, the pathways are not yet well-understood.

Study aims

Aim 1: To group WLHIV by PTSD symptom combination and severity. Aim 1 will group women by PTSD symptom combination of severity, then examine contextual factors associated with probable membership in each PTSD group. This aim allows a greater understanding of the contextual factors and challenges faced by WLHIV who also have PTSD. Specifically, it groups WLHIV into latent classes by PTSD symptom severity and identifies the associated sociodemographic characteristics of women in each group.

Aim 2: To prospectively examine if PTSD symptoms predict future HIV care outcomes and behavior. Aim 2 quantifies the association between PTSD latent classes and future HIV care outcomes and behaviors (medication adherence, CD4<200, detectable viral load). The results from this aim will point to whether or not PTSD is related to HIV outcomes and behaviors and may offer suggestions for clinical care of individuals living with HIV and PTSD.

Aim 3: To test whether current PTSD latent classes remain stable over time. Aim 3 examines whether probable membership in PTSD latent classes at one time remains consistent over time using latent transition analysis and quantifies factors associated with persistent or

worsening PTSD. Understanding these factors and the extent of their influence will be important for treatment and programs for women living with HIV and PTSD.

Dissertation organization

This dissertation begins with an introduction that critically reviews the literature on PTSD among women living with HIV, presents the reason for undertaking research in this area, and presents the study aims. Next, there is a methods chapter describing the parent study from which data are drawn, the measures used in this study, a brief description of the study population, how data were collected and quality was assured, data analysis methodology used throughout this dissertation, and concerns specific to using data from human subjects. Following the methods section are each of the three manuscripts: first, a latent class analysis separating the participants into groups based on their PTSD symptomatology (Aim 1); next, a latent class regression quantifying the relationship between probable latent class membership and HIV clinical and behavioral outcomes (Aim 2); and finally, an examination of how PTSD latent class membership changes over time (Aim 3).

Methods

Study design and methodology

This dissertation is a substudy of the ongoing Women's Interagency HIV Study (WIHS, 1994-current; PIs: Dr. Stephen Gange and Dr. Elizabeth Golub). This study uses data from the subset of study sites with PTSD data available: Bronx, NY; Brooklyn, NY; District of Columbia; Los Angeles, CA; San Francisco, CA; and Chicago, IL. The time period used starts at the visit when a PTSD measure was administered to all participants, the PTSD checklist – Civilian Version (PCL-C). It leverages survey data collected on participant demographics, psychosocial characteristics, HIV care behaviors and outcomes (e.g., medication adherence and viral load), and barriers to HIV care. In 2008-2009, WIHS administered the PCL-C across its entire cohort (n=1,098 WLHIV).

The PCL-C is an easy-to-administer, 17-item, 5-point Likert scale (1-not at all 5=very often) (Frank W Weathers et al., 1993). Symptom severity scores range from 17 to 85, and cutoffs may vary by population. For populations with a high prevalence of PTSD, such as the one examined here, a cutoff of 44 is recommended. (National Center for PTSD, 2015b). It was developed by National Center for PTSD, and each item corresponds with a PTSD symptom in the DSM-IV (American Psychiatric Association, 2000). Previous studies have shown the PCL-C to have strong internal consistency, retest reliability, as well as superior convergent and discriminant validity compared with other PTSD measures in a variety of populations (Conybeare, Behar, Solomon, Newman, & Borkovec, 2012; Ruggiero, Ben, Scotti, & Rabalais, 2003; Sherman, Carlson, Wilson, Okeson, & McCubbin, 2005). PCL-C results strongly correlated with other PTSD measurements including gold standard Clinician-Administered PTSD scale, Mississippi scale, PK scale of MMPI-2, and the Impact of Event Scale (Blanchard,

Jones-Alexander, Buckley, & Forneris, 1996; Harrington & Newman, 2007; Sherman et al., 2005). It has been widely used in HIV studies (Katz & Nevid, 2005; Martinez, Israelski, Walker, & Koopman, 2002; Thames et al., 2012). The PCL-C and has the benefit of asking about "a" traumatic event rather than "the" traumatic event, which allows for evaluation of multiple traumatic events rather than a single trauma. Given the high prevalence of abuse in this population, a single traumatic event is highly unlikely (Bacon et al., 2005; Barkan et al., 1998).

Brief description of parent study

In 1994, when the first wave of WIHS participants was recruited, the inclusion criteria were: self-identified woman; able to consent to participation in the study; consented to participation; able to complete the interview in English/Spanish; able and willing to travel to research site every six months (sometimes with assistance); able and willing to participate in interview and physical examination at the research site; and willing to have blood drawn. The inclusion/exclusion criteria were the same for women living with HIV and those without HIV. Women were recruited from community social service organizations, church ministries, HIV primary care clinics, hospital-based programs, research programs, women's support groups, drug rehabilitation programs, HIV testing sites, and referrals from other participants. In 2001, a second wave of WIHS participants was recruited. In this wave, WIHS investigators sought to recruit women who had and had not been exposed to ART. While women from drug treatment centers were not recruited, because of high loss to follow-up among the initial cohort, women in substance use rehabilitation were referred by physicians or friends (Bacon et al., 2005; Barkan et al., 1998). In this wave, participants were required to have a confirmatory HIV test result. WLHIV entering the study did not have AIDS-related conditions, confirmed by review of

medical records. For the ART-exposed group, laboratory reports of HIV RNA levels and CD4 counts concurrent with ART initiation were required. In addition, the women recruited in 2001 were consented to have their specimens stored in a national repository.

WIHS participants provided written, informed consent in English and Spanish for eligibility screening and enrollment into the study. For participants who could not read, the consent form was read to them and this was documented on the consent form. WIHS consent forms included information on current study procedures and on storing specimens in the repository for future studies. Each of the individual consortia, or subsites, has consent forms that are reviewed by the IRB at their local site. Any significant changes in the study protocol and substudies are reviewed by institutional review boards prior to initiation. Participants of WIHS can choose whether or not to participate in any new substudies but are guaranteed a placement in the main WIHS study regardless of their substudy participation. Immediate, direct benefits to participants include a package of incentives: financial compensation for their time; gift packs; bathing and laundry facilities; meals; transportation; and access to dental care at sites where an intensive oral protocol was implemented. All WIHS participants were required to undergo HIV counseling, and were offered health assessment, health education, referral to clinical trials, referral to primary care, and social services.

The WIHS relies on federal funding through these agencies: the National Cancer Institute (NCI), the National Institute on Alcohol Abuse and Alcoholism (NIAAA), the National Institute of Allergy and Infectious Diseases (NIAID), the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD), the National Institute on Drug Abuse (NIDA), the National Institute on Deafness and other Communication Disorders (NIDCD) the National

Institute of Dental and Craniofacial Research (NIDCR), the National Institute of Mental Health (NIMH), and the NIH Office of Research on Women's Health (ORWH).

Measures

3: Table - Variables Used in Aims 1-3

Variable	Type	Description
PTSD symptom severity score, PTSD avoidance and numbing, Re-experiencing symptoms, Hyperarousal symptoms	Continuous Dichotomous (≥44 or <44)	Drawn from PCL-C scale score collected in 2008-2009 (participant visit 29)
Marital status	Categorical	Legally married/common-law married; not married, but living with a partner; widowed; divorced/marriage annulled; separated; never married; other
Race/ethnicity	Categorical	White non-Hispanic; White Hispanic; African-American non-Hispanic; African-American Hispanic; Other (Hispanic); Other (non-Hispanic)
Income	Categorical	Annually $6000 or less; $6001-$12,000; $12,001-$18,000; $18,001-$24,000; $24,001-$30,000; $30,001-$36,000; $36,001-$75,000; $75,000+
Housing	Categorical	Own house / apartment; parent's house; someone else's house/apartment; rooming, boarding, or halfway house; shelter/welfare hotel; on the streets/beach; jail/other correctional facility; residential drug, alcohol treatment facility; other
Substance use	Categorical	Number of alcoholic drinks per week; smoking status; recent use of crack, marijuana, cocaine, heroin, methamphetamines, non-described drugs (e.g., methadone), hallucinogen
Paid employment	Dichotomous	Yes, no (includes part-time)
Depression	Continuous	Assessed using CES-D (Radloff, 1977)

Variable	Type	Description
CD4 count, viral load	Continuous	Collected at 6, 12, 18, and 24 months following 2008-2009 (participant visits 30-33)
ART use	Dichotomous	Y/N measured at 6, 12, 18, and 24 months following 2008-2009 (participant visits 30-33)
Past adult sexual abuse, past adult physical abuse	Dichotomous	Code "1" for sexual abuse reported AND no sexual abuse reported before age 18; Code "1" for first physical abuse reported at age 18 or later
Child physical abuse; child sexual abuse	Dichotomous	Code "1" for first physical abuse reported before age 18; Code "1" for first sexual abuse reported before age 18
Psychological abuse	Dichotomous	Current or past partner control not distinguished in the data. Participant reports yes to 1 of 7 controlling behaviors (threatened to be hurt or killed, prevented from leaving the house, prevented from seeing friends, prevented from making phone calls, prevented from getting or keeping a job, prevented from continuing education, prevented from seeking medical attention).
Current physical abuse	Dichotomous	Code "1" for physical abuse reported in past 6 months at 6, 12, 18, and 24 months following 2008-2009 (participant visits 30-33)

Study Population

The study population of the WIHS is approximately 3,500 women living with and without HIV with data available from 2008-2009 (Bacon et al., 2005). The median age among women living with HIV enrolled in 1994 was 36, and in 2001, it was 33. Participants were generally of low SES including high unemployment; a low, unchanged median income between 1994 and 2001; little education; living below the poverty line; and without health insurance. Many participants also lacked stable housing. The majority of those for whom risk exposure is known were exposed to HIV through heterosexual sex (WIHS Data Management and Analysis Center, 2016).

This study focuses on the subset of women with HIV who have PTSD data available at visit 29 and subsequent visits (n=1,098). These were all women who opted into an additional substudy called the neurocognitive study. Below is a table describing the demographic characteristics of those included in the study and statistical tests of differences between those who did not opt in to the study. The populations are similar in terms of employment, education, sexual identity, and health insurance but differ slightly in that those opting in to the neurocognitive substudy are slightly older (mean age of 46.3 vs. 44.7), more likely to be born in a U.S. state, and more likely to be stably housed.

4: Table - Sociodemographic characteristics of women with and without PTSD data

	With PTSD Data (n=1098)		Without PTSD Data (n=323)		Test statistic
Age					
Mean	46.3		44.7		p=0.003
	N	**%**	**N**	**%**	
Country of birth					
U.S.	858	78.1%	198	61.3%	p<0.001
Puerto Rico or other U.S. territories	32	2.9%	12	3.7%	
Other countries	208	18.9%	113	35.0%	
Currently employed					
No	690	62.8%	123	38.1%	p=0.185
Yes	408	37.2%	58	18.0%	
Missing	0	0.0%	142	44.0%	
Education					
Less than high school	395	36.0%	135	41.8%	p=0.062
Completed high school	314	28.6%	95	29.4%	
Some college or more	389	35.4%	93	28.8%	
Housing					
Own house or apartment	945	86.1%	147	45.5%	p<0.001
Other	153	13.9%	176	54.5%	
Income					

$18,000 or less	671	61.1%	141	43.7%	p<0.001
>$18,000 per year	423	38.5%	38	11.8%	
Missing	4	0.4%	144	44.6%	
Marital status					
Partnered	350	31.9%	75	23.2%	p=0.04
Single	663	60.4%	95	29.4%	
Other	84	7.7%	11	3.4%	
Missing	1	0.1%	142	44.0%	
Sexual identity					
Heterosexual/straight	959	87.3%	295	91.3%	p=0.145
Bisexual, Lesbian/Gay, Other	133	12.1%	27	8.4%	
Missing	6	0.5%	1	0.3%	
Has health insurance?					
No	63	5.7%	5	1.5%	p<0.10
Yes	1035	94.3%	176	54.5%	
Missing	0	0.0%	142	44.0%	

Participants were drawn from six sites including Bronx NY; Brooklyn, NY; Washington DC; Los Angeles, CA; San Francisco, CA;, and Chicago, IL. There was relatively little current drug use among the study population:

5: Table - Participant first visit site, recent drug use (n=1,098)

	n	%
Site at which participant completed first visit		
Bronx, NY	214	19.5%
Brooklyn, NY	221	20.1%
Washington DC	157	14.3%
Los Angeles, CA	164	14.9%
San Francisco, CA	173	15.8%
Chicago, IL	169	15.4%
Drug use		
Recent cocaine use	18	1.6%
Recent crack use	50	4.6%
Recent heroin use	15	1.4%

Recent use of amphetamine, narcotics, or hallucinogens	3	0.3%

Data Collection

Participants undergo one visit per 6-month study "window" (Apr 1-Sep 30; Oct 1-Mar 31). In each appointment, investigators conduct a core interview, physical and gynecological exams, specimen collection for laboratory tests, and study outcomes. Data used in this substudy are drawn from the core interview, which includes sociodemographics, medical/medical health history, medication use, substance use and sexual history, health care utilization, psychosocial measures, and abuse history. There is also a neurocognitive battery, which includes the Posttraumatic Checklist-Civilian Version (PCL-C). Participants are never removed from the study due to missed visits.

All study interviewers were trained together when the WIHS began and prior to its second major round of recruitment (2001-2002). Each WIHS location had one "lead" interviewer and was responsible for orienting new staff and evaluating interviewers annually. Interviewers also receive detailed guidance each time new questions are introduced (Bacon et al., 2005).

Data Analysis

In Aim 1, I use a person-centered approach to explore heterogeneity in PTSD symptomatology among WLHIV by empirically defining and describing subgroups of WLHIV using MPlus software (Muthén & Muthén, 2006). Using the latent classes, I then examine psychosocial correlates and contextual factors of probable class membership.

Dichotomized responses to the posttraumatic symptom checklist (PCL-C) collected from all participants in 2008-2009 are used (n=1,098) to model latent classes. In Aim 1, I then use

latent class regression to examine correlated individual and contextual factors measured during the same visit. After examining the fit statistics for the most parsimonious model (one class), I test models with increasing numbers of classes while monitoring the goodness-of-fit statistics, such as the Lo-Mendel-Rubin Likelihood Ratio Test, Akaike Information Criterion, and Bayesian Information Criterion to identify the optimal model (Akaike, 1987; Lo, Mendell, & Rubin, 2001; Schwarz & others, 1978). Once latent classes were estimated, participants were grouped into classes based on the probability of class membership using a manual 3-step approach executed in MPLUS. This approach accounts for the uncertainty of class assignment and does not incorporate correlates of class membership into model estimation. Using these class assignments, I explore sociodemographics, psychosocial factors, as well as current and past violence experience by PTSD severity class using latent class regression. Taken together, these correlates provide a comprehensive overview of the context of women living with HIV and PTSD.

While no formal approach exists to calculate sample sizes for LCA, class sizes, the number of classes, overall prevalence of items, and the number of items (>5) are important considerations. There are 17 items, which far exceeds the threshold of 5 items. Given the relatively large sample size (n=1,098), the sample size is sufficient to perform this LCA (Dziak, Lanza, & Tan, 2014). I then use distal latent class regression to test whether PTSD latent classes predict future HIV care outcomes and behaviors (medication adherence, CD4<200, undetectable viral load) using MPLUS software and controlling for relevant sociodemographics and violence experience (Muthén & Muthén, 2006). Missing data were imputed using multiple imputation chained equations in Aim 2 in STATA. Participant sociodemographic data was largely complete and was used to impute missing violence data and outcome data (undetectable viral load and

CD4 count consistent with AIDS). The amount of missing CD4 and viral load data ranged from 4.7% to 16.0%. Finally, I use latent transition analyses to examine the extent to which the PTSD latent classes determined in Aim 1 are stable over time. Here, HIV outcomes, behaviors, sociodemographics, and violence experiences are examined as correlates of transitioning between classes using multiple logistic regression.

Human Subjects

The Women's Interagency HIV Study (WIHS) is currently being carried out at 11 U.S. sites. The data coordination center is located at the Johns Hopkins Bloomberg School of Public Health (JHSPH) in the Department of Epidemiology. Recruitment, informed consent, and data collection are conducted at each of the 11 sites.

Sources of Data

Detailed interviews and specimen collection are conducted every six months for all WIHS participants. Trained interviewers conduct data collection and are evaluated annually. To identify participants, only study identification numbers are used on WIHS documentation rather than names. Names are only used where necessary (consent forms, locator forms, and medical record requests). Forms with identifiers are kept separately in a secured file cabinet separate from the main data files. All data are stored securely at the WIHS Data Management & Analysis Center in the Department of Epidemiology at the Johns Hopkins Bloomberg School of Public Health. During analysis for this research, all data were stored on an encrypted drive on a password protected computer. No personal identifiers are included in the data used for this study.

Potential Risks

The major risk of participation described by WIHS participants is the stigma of being associated with a study on HIV. Participants fear that if it becomes known that she is part of WIHS, others may assume that the participant is living with HIV (not all WIHS participants are living with HIV). Other risks from participation include potential physical discomfort during specimen collection. Another risk is potential psychological discomfort from the interview, which includes questions on sensitive issues or stigmatized behaviors such as substance use and sex behavior. Interviewers from all 11 sites are trained together and undergo a detailed, annual evaluation.

Protections against Risk

This substudy includes several of its own protections against risk in addition to those of the parent study (described below). As a secondary data analysis, this research does not require contact with participants. The major, potential risk is of a data leak. To address this potential, all data used for analysis were de-identified and contain only the variables listed above and a randomly-assigned participant ID. All data will be stored on a password-protected computer. Within this computer, data will be stored on an encrypted drive (Cyperix LE, 2016).

Within the parent study, several procedures are in place to protect against risk of participation in the WIHS:

1. Community advisory boards: Each WIHS consortium has a community advisory board made up of WIHS participants. They select representatives for the national community advisory board. Their responsibilities include participating in the main WIHS leadership meeting (called the Executive Committee), various working groups, and reviewing plans and

rationales for protocol changes and assisting researchers in understanding what new initiatives are likely to be supported by study participants and what questions are of importance to the community of women living with HIV.

2. Certificate of confidentiality: A certificate of confidentiality from the U.S. Department of Health and Human Services protects study staff from being required to respond to requests for information on participants from any persons or organizations unrelated to the study.
3. Standard operating procedures for data collection and management: Participants are assigned study identification numbers and names are not used on any WIHS documentation except where necessary (consent forms, locator forms, and medical record requests). Forms with identifying information are maintained separately from data files in a secured file cabinet. No identifying information will be part of any datasets used in the research.
4. Institutional Review Board: Each WIHS consortium, or location, must go through the Institutional Review Board process for the main WIHS study as well as any substudies under consideration.

Paper 1: Posttraumatic stress symptom latent classes and their correlates among U.S. women living with HIV

Introduction

Traumatic events are associated with proportionally increased risk for poor physical health, HIV, and death (M. H. Cohen et al., 2004; Hatcher et al., 2015; Leserman et al., 2005, 2007; Lichtenstein, 2006; M. J. Mugavero et al., 2009; Schafer et al., 2012). Women living with HIV (WLHIV) experience disproportionately high rates of victimization, such as intimate partner violence, physical assault, and childhood sexual assault (Brezing et al., 2015; Kouyoumdjian, Findlay, Schwandt, & Calzavara, 2013; E. L. Machtinger et al., 2012; Brian Wells Pence et al., 2007; Raja et al., 2015; Siemieniuk, Krentz, & Gill, 2013; Wyatt, Myers, & Loeb, 2004).

Posttraumatic Stress Disorder

Post-traumatic stress disorder (PTSD) is another result of exposure to violence among WLHIV. It is a psychiatric disorder whose symptoms are grouped into three clusters: hyperarousal, avoidance and numbing, and re-experiencing described in the Diagnostic and Statistical Manual IV (American Psychiatric Association, 2000). Five of the 17 symptoms related to hyperarousal, 7 to avoiding trauma reminders and numbing behaviors; and the remaining 5 to re-experiencing the trauma (American Psychiatric Association, 2013a). Each of these symptom groups has different clinical implications (Sikkema et al., 2013; T. P. Sullivan & Holt, 2008). Women and men are differently affected by PTSD: earlier studies have observed that women are more affected by PTSD than men controlling for the number of traumatic events, and the causes may be comprised by genetic and societal factors (Chung & Breslau, 2008; L. Duncan et al., 2017). A recent meta-analysis found that 30% of U.S. WLHIV had recent PTSD (within 6

months) compared to only 8% of all U.S. women. Among WLHIV, PTSD may lead to poorer physical health including increased HIV disease progression and lower CD4 cell counts (Adams et al., 2016; E. L. Machtinger et al., 2012; Brian Wells Pence et al., 2007).

PTSD is generally conceptualized as binary where individuals either do or do not meet criteria for the diagnosis (American Psychiatric Association, 2000) However, earlier studies of PTSD have found that even subclinical levels of PTSD carry significant functional impairment (Brancu et al., 2016). In addition, other studies have shown a range of PTSD symptom number and severity among those diagnosed with PTSD or with symptoms that would meet the diagnostic threshold for PTSD (O'Campo et al., 2006). These insights suggest that a fuller understanding of how PTSD is manifested could provide valuable insight for addressing this disorder. Several such studies have taken place among populations with high rates of PTSD, such as war veterans, but such in-depth examination of PTSD has not yet been conducted for WLHIV (Ayer et al., 2011; Naomi Breslau et al., 2005; C. L. Hebenstreit, Maguen, Koo, & Deprince, 2015; C. Hebenstreit, Madden, & Maguen, 2014; Hellmuth, Jaquier, Swan, & Sullivan, 2014; Maguen et al., 2013; Steenkamp et al., 2012).

Previous latent class analyses examining PTSD

Several earlier studies have used latent class analysis or latent profile analysis to describe PTSD symptom patterns and severity. These statistical techniques group participants by similar symptom profiles including patterns and severity. Eight studies have used these statistical techniques to the 17 DSM-IV PTSD symptoms. These studies describe PTSD among veterans of recent wars; Vietnam veterans; adolescents; community-based samples in urban areas; and women experiencing intimate partner violence (IPV) (Ayer et al., 2011; Naomi Breslau et al.,

2005; C. L. Hebenstreit et al., 2015; C. Hebenstreit et al., 2014; Hellmuth et al., 2014; Maguen et al., 2013; Steenkamp et al., 2012).

The latent class models across all eight studies have several similarities. All found three to five latent classes with varying severity. Most of these studies also found a substantial proportion (>50%) of participants to be in a latent class with low to no disturbance, that is, little endorsement of any PTSD symptoms. A smaller class (10-15% depending on the study) reported high endorsement of PTSD symptoms. The models differed in symptom type in each class. Specifically, four analyses found that higher endorsement of emotional numbing symptoms were the sole factor distinguishing the highest severity class from the next most severe class (Naomi Breslau et al., 2005; C. Hebenstreit et al., 2014; Maguen et al., 2013). A closely related method - latent profile analysis – applied to data collected from a group of women exposed to intimate partner violence, found hyperarousal symptoms to differentiate classes (C. L. Hebenstreit et al., 2015).

Of all of these PTSD studies mentioned above, four examined the relationship between trauma experience and class membership. The remaining five did not look at the correlation between trauma and probable latent class membership. One study examining veteran PTSD experience found that killing in a combat context, particularly non-combatants and in a context of anger or revenge, was associated with more severe PTSD (Maguen et al., 2013). For the studies among civilian populations, one found no relationship between trauma severity and PTSD severity among women exposed to IPV (C. L. Hebenstreit et al., 2015); another found differences in trauma type with assaultive violence most strongly predicting severe PTSD when compared to unexpected death, injury or shock, or trauma to others in a community sample (Naomi Breslau et al., 2005); and the last found the most severe psychological, physical, and

sexual IPV experiences to be associated with the highest PTSD latent class (Hellmuth et al., 2014). The last study mentioned was conducted among women experiencing bidirectional IPV. Our population is somewhat different than the populations in earlier PTSD latent class studies. The women whose data are analyzed here are largely civilian women who were not selected on the basis of having experienced violence, and many live in situations of material deprivation (Bacon et al., 2005). Previous research has not examined how PTSD manifests in this highly affected population. Still, our hypotheses are drawn from the best available earlier work, which is the PTSD latent class studies described. In particular, we focused on the studies conducted among women experiencing IPV because this population may have the most similarities with WLHIV given the high prevalence of trauma experience among WLHIV. While there are some veterans of war in this sample, it is not the majority of participants.

The results from these investigations have aided healthcare providers and program planners in understanding the PTSD severity, characteristics, and any unique subtypes among each of these groups. These insights can be used to tailor treatment plans and programs to individuals with likely membership in each latent class group. However, studies of PTSD are limited among populations living with HIV, despite its frequency among WLHIV and its association with poor health outcomes (Applebaum et al., 2015).

Research questions

In this study, we wish to address some of the gaps in the previous literature described above. We also want to examine predictors of latent class membership, especially sociodemographic characteristics and previous violence experience. Sociodemographics, in particular, have not been examined in the context of PTSD among WLHIV but are important for

understanding the social and structural context of WLHIV who are experiencing PTSD. The wide-reaching deleterious effects of violence against WLHIV, and the high prevalence of PTSD among WLHIV, make this a priority issue for this population (Kouyoumdjian et al., 2013). Earlier reviews have called for research into this area, which can be applied to treatment approaches, and, in particular, program planning for this population.(Blashill et al., 2011) Additionally, many previous studies of WLHIV have characterized physical violence and do not consider the impact of emotional violence (e.g., threats) nor the effects of multiple types of violence. By using detailed violence measures spanning the life course, we hope to shed light on various experiences of violence among WLHIV with different manifestations of PTSD.

Our specific research questions are: 1) given the lack of research into the characteristics of PTSD in this population, what are the patterns of PTSD symptoms among WLHIV? 2) What type, intensity, and frequency of violence experience characterize each latent class? We hypothesize that – similar to previous PTSD studies of women experiencing intimate partner violence – WLHIV will be classified into three or four latent classes that differ by both symptom severity and configuration. Specifically, we hypothesize that the avoidance and numbing symptom cluster will differentiate the medium and high classes as has been shown in previous studies. We also hypothesize that one latent class will contain a majority of the population who will have experienced little violence and do not report any PTSD symptoms, and that a small latent class distinguished by high PTSD severity will contain individuals who have experienced multiple, severe types of violence before adulthood.

Methods

Study population and data collection

This study uses data from the Women's Interagency HIV Study (WIHS), an ongoing, multisite longitudinal cohort study of WLHIV and at risk for HIV. This study and the full cohort has been described in detail elsewhere (Bacon et al., 2005; Barkan et al., 1998; WIHS Data Management and Analysis Center, 2016). This analysis focuses on participants living with HIV with complete post-traumatic stress disorder symptom (PTSD) measurement between October 1, 2008 and March 31, 2009. The site located in Los Angeles did not collect violence-related data at that time due to state reporting requirements; hence, the parts of this analysis that examine violence do not include data from Los Angeles. All participants completed the interviewer-administered, self-report posttraumatic checklist-civilian version (PCL-C) for the first time. Data collected include sociodemographics, psychosocial measures, and abuse experience. This substudy was approved by the WIHS Executive Committee, which is a group comprised of investigators, funders, community members, and study staff. It was also approved by the Institutional Review Board at each study site. All participants provided written informed consent for study entry.

Measures

Demographic characteristics included age (years), race (White, African-American, Other, Asian/Pacific Islander, Native American/Alaskan). The “Other” category is a combination of responses including Native American, Asian/Pacific Islander, Hispanic non-white, and non-African American other. Demographic measures included ethnicity (Hispanic, non-Hispanic), country of birth, employment status, marital status, and health insurance. At the baseline visit,

participants were asked their highest level of education (less than high school, high school, at least some college) and sexual identity (heterosexual/straight, bisexual, and lesbian/gay).

PTSD symptom severity was measured using the PCL-C which is a 17-item, 5-point Likert scale (1=not at all, 2=a little bit, 3=moderately, 4=quite a bit, 5=extremely) (Frank W Weathers et al., 1993). Symptom severity scores range from 17 to 85, and cutoffs vary by population with 33 recommended generally and 44 recommended for populations where PTSD prevalence is high. It was developed by National Center for PTSD, and each item corresponds with each of 17 PTSD symptoms in the DSM-IV (e.g., "Suddenly acting or feeling as if a stressful experience were happening again (as if you were reliving it)?" (National Center for PTSD, 2015b). Items are grouped into three clusters: re-experiencing (items 1-5), avoidance and numbing (items 6-12), hyperarousal (items 13-17). Re-experiencing symptoms relate to reminders of traumatic events (e.g., "Feeling very upset when something reminded you of a stressful experience from the past?"). Avoidance and numbing symptoms describe avoiding reminders of the trauma or numbing behaviors (e.g., "Feeling emotionally numb or being able to have loving feelings for those close to you?"). The third cluster, hyperarousal, groups together symptoms of increased alertness, such as "Feeling jumpy or easily startled?" The PCL-C symptom scale has the benefit of asking reactions associated with "a" traumatic event rather than "the" traumatic event, which allows for evaluation of multiple traumatic events rather than a single trauma (American Psychiatric Association, 2000). Given the high prevalence of abuse among WLHIV, a single traumatic event is highly unlikely (Bacon et al., 2005; Barkan et al., 1998; E. L. Machtinger et al., 2012).

Previous studies have shown the PCL-C to have strong internal consistency, retest reliability, as well as superior convergent and discriminant validity compared with other PTSD

measures in a variety of populations (Conybeare et al., 2012; Ruggiero et al., 2003; Sherman et al., 2005). PCL-C results strongly correlated with other PTSD measurements including gold standard Clinician-Administered PTSD scale and have been widely used in HIV studies (Blanchard et al., 1996; Harrington & Newman, 2007; Katz & Nevid, 2005; Martinez et al., 2002; Sherman et al., 2005; Thames et al., 2012) and among women who have experienced intimate partner violence (Pitpitan et al., 2012; Rodriguez et al., 2008; Schafer et al., 2012).

Sexual abuse was described as follows, “Has anyone pressured or forced you to have sexual contact? By sexual contact I mean them touching your sexual parts, you touching their sexual parts, or sexual intercourse.” Lifetime history was assessed by asking participants whether they had experienced sexual abuse before age 18, sexual abuse in the previous year, and identity of sexual abuser (parent, family, intimate partner, acquaintance, stranger) at enrollment into the study. Prior to this questionnaire, participants had been asked about sexual abuse since the last study visit.

Lifetime history of physical abuse was assessed using the following question, “Have you ever experienced serious physical violence (physical harm by another person)? By that I mean were you ever hurt by a person using an object or were you ever slapped, hit, punched, or kicked?” Participants were then asked about abuse in the previous year, and identity of abuser (parent, family, partner, acquaintance, or stranger). Participants had been asked about serious physical abuse at the previous visit (6 months prior), participants were asked about abuse since the last visit. Participants were not asked about how frequently abuse occurred.

Ever experiencing controlling behaviors was included if participants responded “yes” to experiencing any of the following from a current or previous partner: "threatened to hurt or kill you", "prevented you from leaving or entering your house", "prevented you from seeing friends",

"prevented you from making phone calls", "prevented you from getting or keeping a job", "prevented you from continuing your education", "prevented you from seeking medical attention". Another measure examining psychological abuse included "has your current or previous partner ever threatened you when you talked about using a condom or other barrier method (such as dental dams)?" (yes/no).

Participants who reported being in a relationship were asked whether they were afraid of their current partner, feel their current partner might try to kill them, or is afraid to go home (yes/no). Whether or not the participant experienced a recent threat to be hurt or killed by her partner (last 1 year) was also measured.

Statistical analysis

We used descriptive statistics to examine participant characteristics, violence experience, and PTSD prevalence. We then conducted latent class analysis on dichotomized participant responses to each of the 17 symptom questions from the PCL-C.(Muthén & Muthén, 2006) The responses were dichotomized into two levels 1 (“moderately”, “quite a bit”, “extremely”) vs. 0 (“not at all”, “A little bit”). This dichotomization was in accordance with PCL-C scale scoring methodology and previous analyses using this measure (Maguen et al., 2013; National Center for PTSD, 2015c).

To explore PTSD symptoms subgroups, we conducted latent class analysis on the 17 items of the PTSD scale. We examined fit statistics for the most parsimonious model, which is a single latent class, then tested models with increasing numbers of classes. We examined and compared the goodness-of-fit statistics for each model including the Lo-Mendel-Rubin Likelihood Ratio Test, Akaike Information Criterion (AIC), and Bayesian Information Criterion

(BIC). Based on these fit statistics, we picked the best fitting model (Akaike, 1987; Lo et al., 2001; Schwarz & others, 1978).

We used 3-step latent class regression to test the relationship between demographic and violence experience characteristics with probable membership in each PTSD latent class (Asparouhov & Muthen, 2015; Asparouhov & Muthén, 2014; Vermunt, 2010). This method accounts for the uncertainty of class membership because it does not simply use the modal probability to assign class. We also examined these latent class models with ordinal, rather than dichotomized, item response scores (where item scores were considered on a scale from 1-5) to compare solutions. We computed risk ratios for each of the PTSD classes comparing levels of demographic/violence predictor variables based on model-predicted probabilities of class membership conditional on predictors. These analyses were conducted using MPLUS software (Muthén & Muthén, 2006). Data management and initial analyses were conducted in R (R Core Team, 2013; Wickham & Francois, 2016; Wickham, Hester, & Francois, 2016).

Results

Participant Demographics

There were 1,098 WLHIV participants with PTSD data. Among them, the mean age was 46 (SD=8.9). The majority was African American (62%), non-Hispanic (75%), and born in the U.S. (78.1%). most were unemployed (62.8%) and had high school or less education (64.6%). A majority lived in their own house or apartment (86.1%), and earned $18,000 per year or less, which was below the federal poverty level for a 3-person family ($18,310) at the time of the

survey (Office of the Assistant Secretary for Planning and Evaluation, 2009). Most participants identified as heterosexual (87.3%) and had health insurance (94.3%) (Table 6).

Overall Prevalence of PTSD by varying cutoffs

Among all 1,098 participants, 29% of participants had PTSD symptom severity consistent with a diagnosis threshold of 33. Using a higher cutoff of 44 that indicates greater symptom severity, the percentage of participants with PTSD dropped to 14%. When the PCL-C was scored by presence of symptoms in each cluster, 13% of participants' PTSD scores aligned with a clinical diagnosis (data not shown). In this study, the internal consistency measured by Cronbach's alpha was 0.95.

Violence experience

Of the participants with violence data, 67.8% had experienced abuse in their lifetimes. Forty-two percent of all participants had experienced sexual violence. Among those, almost half experienced sexual violence before age 18 (Table 9); for one third the perpetrator was a parent; and for half of those who had experienced sexual violence, the perpetrator was a family member. Almost one quarter reported that the perpetrator was an intimate partner; and 33% reported that the perpetrator was a stranger (Table 9). Fifty four percent of participants reported ever experiencing serious physical violence. Among those, for the majority (74%), the perpetrator was an intimate partner; for 33%, the perpetrator was a parent (not mutually exclusive; Table 9). Thirty-nine percent of participants reported that their partners engaged in at least 1 controlling behavior. A third (33%) reported that a current or previous partner had threatened to hurt or kill her or that she feels her current partner might try to kill her (Table 9).

Thirty-two percent of participants reported both physical and sexual abuse in their lifetimes, and 21% of participants reported experiencing physical, sexual, and psychological abuse. Only 4.4% reported any recent abuse (previous year; Table 9). Thirty-two percent of participants reported physical or sexual abuse by a family member, and 41% of participants reported abuse by partner. Nineteen percent reported abuse by both family and partner. These intersections are shown in Figure 10.

Latent Class Model

Out of models with different numbers of classes, we selected the three-class solution. It had the lowest BIC, and was indicated as the best model by the Vuong-Lo-Mendel-Rubin LRT (significantly better fit than the two-class model and not significantly worse fit than the four-class model) (Table 7). Generally, BIC performs better as a test of model fit than AIC, and the Vuong-Lo-Mendel-Rubin LRT allows for statistical testing between nested models (Karen L. Nylund, Asparouhov, & Muthén, 2007). Clinical utility also best supported this model: we did not consider models with classes whose prevalences were much lower than 10%. This three-class solution also has very good class separation (entropy=0.93 and correct classification probabilities ranging 0.932 to 0.986).

These model results show a low, medium, and high severity class where members of the high severity class had the highest probable endorsement of each symptom, followed by the medium and then low classes (Figure 8: Figure). While the symptom configuration did not differ between classes, only the intensity of symptoms, the classification emerged from the data itself. Most of the sample was in the low severity class (65.5%), which means that for almost all symptoms, members did not experience them at all or only experienced them some of the time.

In this class, only the insomnia and hypervigilance symptoms had a probable endorsement of >0.1, which signifies experiencing them some of the time. On the other hand, the high severity class (9.2%) had conditional probability of >0.7 of experiencing each symptom "moderately", "quite a bit" or "extremely". Amnesia was the one exception with only 0.625 probability of members experiencing it (8: Figure). The medium severity class (25.2% of sample) had moderate conditional probability for each item with slightly higher endorsement for insomnia and hypervigilance compared to other symptoms.

Differences across Latent Classes

Predicted class prevalence and risk ratios conditional on demographic variables are presented in Table 11. Examining risk ratios (RRs), latent classes did not differ by ethnicity (Hispanic vs. non-Hispanic), marital status, or health insurance status. Participants who did not identify as Black/African-American or White were less likely than White participants to be in the medium severity class. Participants born in the U.S. were significantly more likely to be in the medium severity group (RR=1.81, CI: 1.18-2.43) compared to those born outside of U.S. states (Puerto Rico, other U.S. territories and other countries). U.S. born participants were also less likely to be in the low severity group (RR=0.81, CI: 0.73-0.88) compared to those born outside the U.S. Those identifying as a sexual minority (bisexual, lesbian/gay, or other) were significantly more likely to be in the high (RR=1.96, CI: 1.05-2.88) or medium severity classes (RR=1.42, CI: 1.01-1.82) compared to those identifying as heterosexual. They were also less likely to be in the low severity class (RR=0.74, CI: 0.60-0.87).

Overall, participants with higher socioeconomic status had an increased likelihood of being in the low severity PTSD latent class. Specifically, for education, those with at least some

college experience were less likely to be in the medium severity class (RR=0.35, CI: 0.16-0.54) and more likely to be in the low severity class (RR=1.28, CI: 1.15-1.41) compared to participants who did not complete high school (reference group). Participants with an income higher than $18,000 annually at the time of data collection were less likely to be in the high (RR=0.50, CI: 0.29-0.71) or medium (RR=0.73, CI: 0.57-0.89) severity classes, but more likely to be in the low severity class (RR=1.24, CI: 1.13-1.36). Similarly, employment was related to PTSD latent class: those who were employed were less likely to be in the medium (RR=0.67, CI: 0.50-0.83) or high (RR=0.29, CI: 0.12-0.45) severity latent classes and more likely to be in the low severity class (RR=1.32, CI: 1.20-1.43). Those with stable housing were less likely to be in the medium severity group (RR=0.69, CI: 0.51-0.88) and more likely to be in the low severity group (RR=1.27, CI: 1.06-1.48) compared to those with less stable housing.

Predicted class prevalence and risk ratios conditional on violence experience variables are presented in Table 2. Violence experience related to significantly greater likelihood of being in the high severity class included 1) sexual assault by acquaintance or stranger; 2) recent sexual assault; 3) recent physical assault; 4) reporting at least 1 of 7 partner controlling behaviors, as well as experiencing multiple types of violence. Those in the high severity class were significantly more likely to have experienced both sexual and psychological abuse, any recent abuse (sexual, physical, or psychological), or all three types of abuse (physical, sexual, and psychological) from any perpetrator. Significant predictors of membership in the medium severity class included any experience of sexual violence; sexual violence before age 18; sexual assault by a parent; experience of physical violence; physical violence by family; physical violence by an intimate partner; physical violence by an acquaintance; physical violence by both a family member and intimate partner; reporting 1 of 7 partner controlling behaviors; or

participant fearing she might be killed by a current or previous partner. Importantly, only recent physical or sexual abuse and sexual assault by an acquaintance or stranger was associated with membership in the highest severity class but *not* membership in the medium severity class.

Discussion

In this study, 29% of participants had recent PTSD symptoms consistent with a diagnosis compared to 5.2% of U.S. women (Harvard Medical School, 2005). Characteristics associated with PTSD here include white race, being born in the U.S., sexual minority identity, lack of employment, lack of college education, lack of stable housing, and income below poverty level were correlates of medium and high PTSD severity classes. These findings largely align with previous studies. However, those identifying as Asian/Pacific Islander, Native American/Alaskan, other were less likely to be in the medium PTSD severity class compared to Whites. Previous PTSD literature finds all minority groups more likely to report PTSD symptoms than Whites (A. L. Roberts et al., 2011). However, one community study did find that White women with incomes less than 125% of the poverty line were the gender and race group most likely to report PTSD symptoms (Parto et al., 2011).

The best fitting model was a three latent class solution describing a high, medium, and low level of PTSD severity without difference in symptom configuration. The three-class solution differentiating levels of PTSD severity is very similar to results of three previous studies of veterans and women experiencing IPV where classes did not differ qualitatively (Ayer et al., 2011; Hellmuth et al., 2014; Steenkamp et al., 2012). This result differs, however, from community-wide samples and veteran populations where classes were characterized not only by increasing severity but also by differences in types of PTSD symptoms, like hypervigilance or numbing symptoms (Naomi Breslau et al., 2005; C. L. Hebenstreit et al., 2015; C. Hebenstreit et

al., 2014; Maguen et al., 2013). The latter studies include men and women, and differences in how PTSD develops and manifests by gender may be one reason why course (N Breslau, Chilcoat, et al., 1999; Walker et al., 2004). Additionally, the type of trauma experienced by participants in the IPV studies may be more similar to participants in this study when compared with studies where the main trauma exposure is events associated with combat.

As expected, physical, sexual, and psychological violence experience was also strongly correlated with PTSD latent class membership. Almost 70% of participants had endured severe violence, often by family members and intimate partners, and these prevalence estimates are far higher than those of all U.S. women. Across all U.S. women, 37% report experiencing sexual violence, physical violence, or stalking victimization (Centers for Disease Control and Prevention, 2010). Interestingly, the violence experiences of participants in the medium and high severity classes were very similar: only recent physical and sexual abuse, as well as sexual assault by acquaintance or stranger, differentiated the medium and high severity classes. This result is different than our hypothesis, where we proposed that violence exposure would be very different between the high and medium classes. The association between recency of traumatic event and severity of PTSD symptoms has been shown in other studies particularly with sexual assault (Steenkamp, Dickstein, Salters-Pedneault, Hofmann, & Litz, 2008). We did not, however, find recent sexual assault to be associated with PTSD latent class membership and believe this to be related to the small number of participants reporting recent sexual assault rather than to the nature of sexual assault itself (n=9). The factors found to be most strongly associated with PTSD in our study, such as early age of sexual assault, relationship to perpetrator, and multiple experiences of abuse are similar to previous studies (Brewin et al., 2000; Kendall-Tackett, Williams, & Finkelhor, 1993; Steuwe, Lanius, & Frewen, 2012). Among those experiencing

multiple types of abuse (physical, sexual, and psychological) over the lifetime and any recent abuse were the strongest predictors of class membership. Factors predicting membership in the medium, but not high, severity classes may have been due to a smaller sample size in the high severity class (9.2% of sample vs. 25.2%) or a true underlying difference where the participant experienced the traumatic event(s) but their PTSD symptomatology was less severe than those in the highest PTSD class.

Almost all participants in the high severity class had PTSD symptoms consistent with clinical diagnosis. The percentage of members of the medium severity class with PTSD symptoms consistent with diagnosis ranged from 14.7% to 76.2% depending on the scoring method used. This suggests that many WLHIV have subthreshold or subclinical PTSD where they meet some but not all criteria for PTSD. Combined with the insight that violence experience was very similar between individuals in the medium and high class, it appears that among the many WLHIV with severe violence experience, there are two distinct PTSD groups. Only the highest severity group appears to be associated with recent or - possibly - ongoing violence. This finding underscores the importance of designing clinical care systems that respond to the needs of individuals who have experienced trauma (i.e., trauma-informed care) (Substance Abuse and Mental Health Services Administration, 2015). It also suggests that a dichotomous definition of PTSD, particularly if a stringent cutoff is used, excludes many women who suffer from ongoing disturbance due to past trauma. Excluding these women may mean that they do not get needed treatment. This identification of two PTSD subgroups has important implications for treatment of PTSD: this group experiences functional impairment and distress that is similar to those whose symptoms meet diagnostic criteria for PTSD. Furthermore, the results of this study point to similar violence experiences and lack of resources between those with clinical and subclinical

PTSD (Cukor et al., 2010). Therefore, similar approaches may be appropriate for women living with HIV and PTSD, as well as those with subclinical PTSD. While previous studies have found differences in PTSD symptom clusters and clinical outcomes, we did not find this result as our latent classes did not differ by symptom configuration, only severity.

These results have implications for PTSD treatment among people living with HIV (PLWH). A 2015 literature review found only two rigorously evaluated treatment approaches for PTSD among PLWH (Applebaum et al., 2015). The authors point to important future research directions including the need for understanding the sociocultural context of PTSD among PLWH (Applebaum et al., 2015). Our study directly responds to this need. It is one of very few available descriptive analyses of the sociocultural context of WLHIV experiencing PTSD. Specifically, the population described here is primarily WLHIV of color (79%), which reflects the broader HIV population of women living with HIV, and we examine PTSD across sociocultural factors such as socioeconomic status, race, and sexual orientation.

Applebaum et al. also state the need for "realistic and functional" programs that can take place "in communities with limited resources" outside of the research settings in which they are often testing (Applebaum et al., 2015)s. Our results point to important insights for such programs. We found that women with HIV and PTSD are frequently also facing a constellation of other unmet basic needs such as stable housing, employment, and income that may exacerbate each other and create further barriers to well-being (German & Latkin, 2012). Previous programs addressing the needs of this population have been unprepared for program clients' high level of need (Jain, Maulsby, Kinsky, Charles, & Holtgrave, 2016). Another important aspect of treating PTSD among PLWH is the presence of multiple manifestations of PTSD, not just the presence or absence. Earlier studies find different treatment outcomes based on types of trauma experience,

which may point to unique PTSD treatment approaches needed depending on an individual's trauma history (Chin et al., 2013). Given the results of this and earlier analyses, future programs should be appropriate and accessible for individuals of sexual minority status (i.e., not heterosexual), minority race, and with few available resources such as income and housing. Future research questions suggested by the results presented here include the relationship between PTSD and sexual orientation among PLWH as well as continued attention to racial and ethnic differences in PTSD experience in this context.

There have been no systematic assessments of how common trauma-informed approaches are within HIV care settings, but models and resources to guide organizations and care providers are available. Specifically, 27 trauma experts, policymakers, and other stakeholders including WLHIV and care providers gathered to examine strategies and propose a framework for trauma-informed care settings tailored to WLHIV (Edward L Machtinger et al., 2015). There are also many resources to guide Ryan White and other HIV care settings towards becoming more trauma-informed (AIDS United, 2018; A. Keuroghlian, 2017).

There are several limitations to this study. This study is cross-sectional; future studies should examine the stability of PTSD and its correlates over time in this population through latent transition analysis to understand whether and how PTSD changes longitudinally. There are also other social and structural factors that may influence PTSD, such as racial discrimination and trauma other than violence, that were not available for this study (Edmondson & Cohen, 2013; Loo, Fairbank, & Chemtob, 2005). Data on other factors that influence PTSD, such as social support and non-medication therapy were not available. Despite these limitations, this study advances the literature on PTSD among women living with HIV: it is the first latent class analysis of PTSD symptom configuration among women living with HIV that explores the

sociocultural context of WLHIV and PTSD. This study also uses a scale and symptoms of PTSD corresponding with the DSM-IV. PTSD symptomatology and clusters have been updated and defined differently in the DSM-V, which may limit comparisons with forthcoming research in this area (American Psychiatric Association, 2013a).

Conclusion

This study found a high prevalence of PTSD and trauma among this sample of WLHIV, which further underscores the urgent need for trauma-informed HIV care. While trauma-informed care is not the norm across clinical settings, models and resources exist to support organizations and care providers in tailoring their care environments to individuals who have experienced trauma (AIDS United, 2018; A. Keuroghlian, 2017; Edward L Machtinger et al., 2015). In our model, PTSD was best described by three latent classes differing in severity: high (9.2%), medium (25.2%), and low (65.5%). PTSD severity was related to other sociodemographic factors such as low income, unstable housing, lack of employment, and sexual minority status but importantly it was strongly related to experiences of violence. Developing and testing treatment models for PTSD among PLWH that are trauma-informed, tailored to the populations most affected, and address unmet needs of participants are urgently needed.

6: Table - Participant demographics (n=1,098)

Characteristic		**N**	**%**
Age			
	<35	134	12.2%
	36 - 40	163	14.8%
	41 - 45	239	21.8%
	46 - 50	232	21.1%

51 - 55	188	17.1%
56+	142	12.9%
Race		
White	232	21.1%
Black/African-American	681	62.0%
All other races (Asian/Pacific Islander, Native American/Alaskan, other)	185	16.8%
Ethnicity		
Hispanic	272	24.8%
non-Hispanic	826	75.2%
Country of birth		
U.S.	858	78.1%
Puerto Rico or other U.S. territories	32	2.9%
Other countries	208	18.9%
Currently employed		
No	690	62.8%
Yes	408	37.2%
Education		
No schooling	4	0.4%
Grades 1-6	37	3.4%
Grades 7-11	354	32.2%
Completed high school	314	28.6%
Some college	303	27.6%
Completed four years of college	62	5.6%
Attended or completed graduate school	23	2.1%
Housing		
Own house or apartment	945	86.1%
Other	153	13.9%
Income		
< $6,000	163	14.8%
$6,001 - $12,000	364	33.2%
$12,001 - $18,000	144	13.1%
$18,001 - $24,000	88	8.0%
$24,001 - $30,000	74	6.7%
$30,001 - $36,000	58	5.3%
$36,001 - $75,000	129	11.7%
> $75,000	74	6.7%
Missing	4	0.4%
Marital status		
Legally or common-law married	251	22.9%
Not married but living with partner	99	9.0%
Widowed	104	9.5%
Divorced or annulled	133	12.1%
Separated	94	8.6%
Never married	332	30.2%
Other	84	7.7%

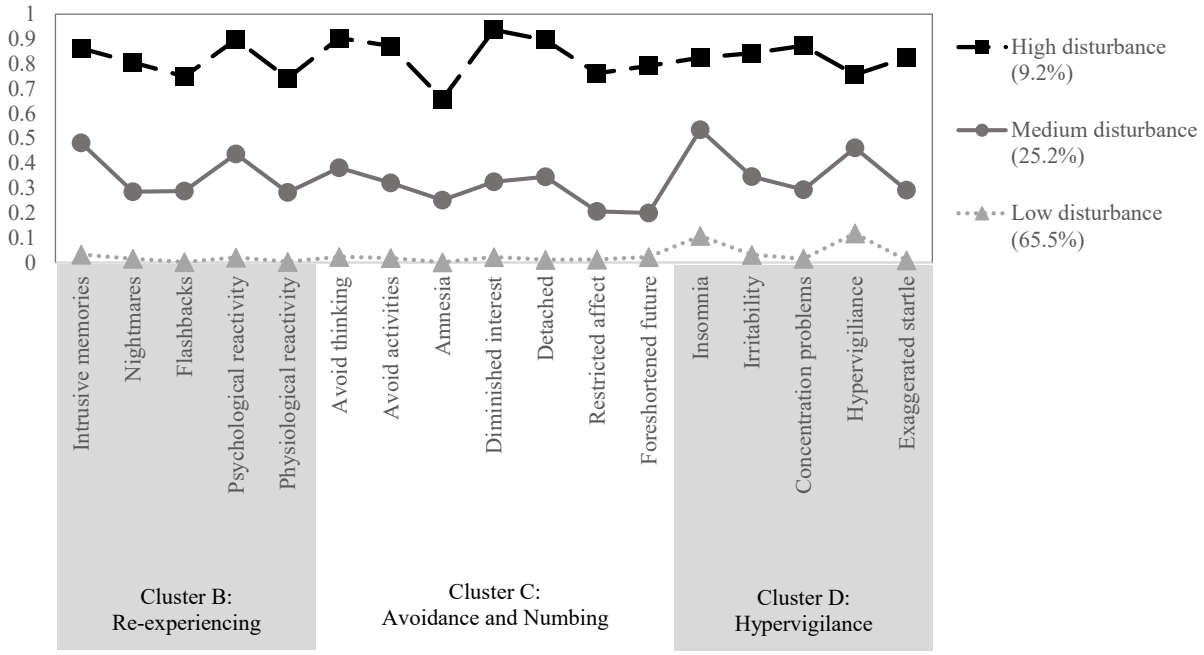
	Missing	1	0.1%
Sexual identity			
	Heterosexual/straight	959	87.3%
	Bisexual	89	8.1%
	Lesbian/gay	41	3.7%
	Other	3	0.3%
	Missing	6	0.5%
Has health insurance?			
	No	1035	5.7%
	Yes	63	94.3%

7: Table - Fit statistics of latent class models

Model	BIC	AIC	VLMR LRT	p-value	Entropy
2-class	12,740	12,565	4,709	0.00	0.95
3-class	**12,144**	11,879	**722**	**0.00**	0.93
4-class	**12,061**	11,705	209	0.09	0.91
5-class	**12,069**	11,624	117	0.34	0.87
6-class	12,110	**11,575**	85	0.19	0.89

Notes: Bold numbers correspond to the number of classes suggested by the criterion.
BIC=Bayesian Information Criterion; AIC=Akaike Information Criterion; VLMR LRT=Vuong-Lo-Mendel-Rubin LRT; BLMR LRT=Bootstrapped Lo-Mendel-Rubin LRT

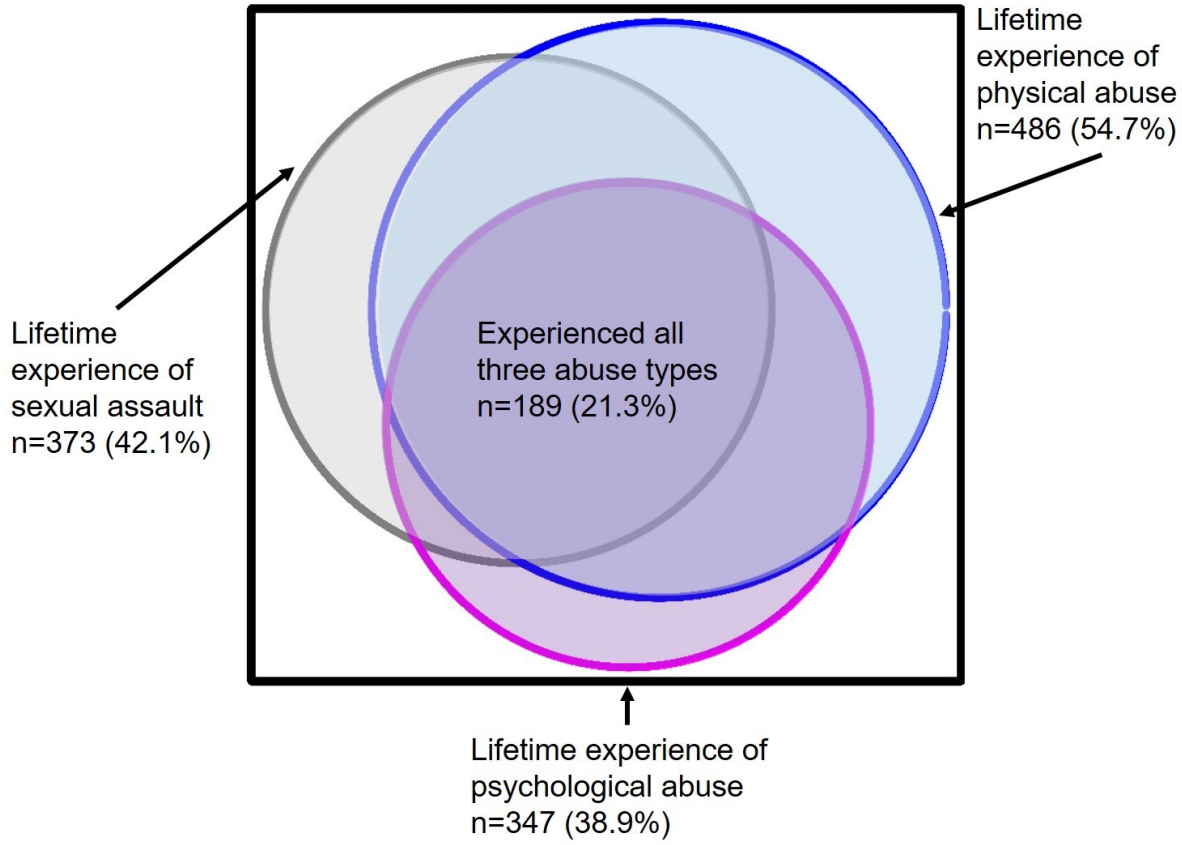
8: Figure - Estimated conditional probability of item endorsement by class



9: Table - Participant violence experience

		N	%
Sexual violence	Any experience of sexual violence	373	42.1%
	Before age 18	173	20.1%
	By parent	130	15.1%
	By any family	184	21.3%
	By intimate partner	88	10.2%
	By acquaintance	63	7.3%
	By stranger	123	14.3%
	By both family member and intimate partner	34	3.9%
	Recent (1 year)	9	1.1%
Physical violence	Any experience of physical violence	486	54.7%
	By parent	157	18.3%
	By any family	180	21.0%
	By intimate partner	351	40.9%
	By acquaintance	26	3.0%
	By stranger	63	7.9%
	By both family member and intimate partner	109	12.7%
	Recent (1 year)	25	2.9%
Psychological violence	Reported ≥1 of 7 partner controlling behaviors*	347	38.9%
	Reported a previous or current partner has threatened to hurt or kill her, feels her current partner might try to kill her	292	32.8%
	Recent psychological violence (1 year)**	22	2.6%
Multiple	Physical or sexual abuse by family	269	31.9%
	Physical or sexual abuse by partner	367	43.4%
	Abuse by family and partner	158	18.8%
	Participant experienced physical and sexual abuse	286	32.3%
	Participant experienced sexual and psychological abuse	216	24.4%
	Participant experienced physical, sexual, and psychological abuse	189	21.3%
	Any recent abuse	40	4.6%

10: Venn diagram showing overlap of sexual, physical, and psychological abuse experience among WIHS participants living with HIV (n=934)



11: Table - Sociodemographic correlates of PTSD latent classes among WIHS participants living with HIV (n=1,098)

	Probability of being in each PTSD latent class, conditional on predictor level			Risk ratio of being in each PTSD latent class comparing predictor levels (95% confidence interval)		
	High severity	Medium severity	Low severity	High severity	Medium severity	Low severity
Race						
White	0.16	0.22	0.62	Ref.	Ref.	Ref.
Black/African-American	0.09	0.26	0.65	1.242 (0.544, 1.940)	1.087 (0.779, 1.396)	0.945 (0.843, 1.047)
All other races[†]	0.17	0.08	0.75	2.508 (0.880, 4.136)	0.332 (0.066, 0.599)**	1.082 (0.935, 1.229)
Ethnicity						
Non-Hispanic	0.09	0.26	0.65	Ref.	Ref.	Ref.
Hispanic	0.09	0.23	0.68	0.908 (0.486, 1.330)	0.886 (0.649, 1.123)	1.059 (0.953, 1.166)
Country of birth						
Outside of U.S.	0.07	0.16	0.77	Ref.	Ref.	Ref.
U.S.	0.10	0.28	0.62	1.352 (0.649, 2.055)	1.806 (1.181, 2.431)**	0.806 (0.732, 0.879)**
Employment						
Unemployed	0.13	0.29	0.59	Ref.	Ref.	Ref.
Employed	0.04	0.19	0.77	0.286 (0.121, 0.451)**	0.666 (0.499, 0.834)**	1.316 (1.202, 1.430)**
Education level						
Less than high school	0.10	0.27	0.63	Ref.	Ref.	Ref.
Completed high school	0.09	0.27	0.63	0.932 (0.486, 1.378)	1.018 (0.749, 1.288)	1.003 (0.884, 1.122)
At least some college	0.10	0.09	0.81	0.968 (0.499, 1.438)	0.351 (0.160, 0.542)**	1.28 (1.151, 1.409)**
Housing						
Less stable housing[‡]	0.13	0.34	0.53	Ref.	Ref.	Ref.
Own house or apartment	0.09	0.24	0.68	0.69 (0.351, 1.029)	0.692 (0.506, 0.879)**	1.272 (1.064, 1.481)**
Income – dichotomized						
Income <18K/year	0.12	0.30	0.58	Ref.	Ref.	Ref.
Income ≥18K/year	0.06	0.22	0.72	0.501 (0.293, 0.708)**	0.731 (0.567, 0.894)**	1.242 (1.126, 1.358)**

	Probability of being in each PTSD latent class, conditional on predictor level			Risk ratio of being in each PTSD latent class comparing predictor levels (95% confidence interval)		
	High severity	Medium severity	Low severity	High severity	Medium severity	Low severity
Marital status						
Never married	0.10	0.27	0.64	Ref.	Ref.	Ref.
Married	0.08	0.21	0.71	0.853 (0.394, 1.312)	0.771 (0.528, 1.014)	1.119 (0.993, 1.245)
Living with partner	0.14	0.21	0.65	1.426 (0.560, 2.292)	0.783 (0.429, 1.137)	1.029 (0.855, 1.202)
Widowed	0.09	0.31	0.61	0.914 (0.247, 1.582)	1.137 (0.730, 1.544)	0.955 (0.783, 1.127)
Divorced	0.08	0.22	0.70	0.801 (0.242, 1.361)	0.815 (0.498, 1.133)	1.108 (0.954, 1.262)
Separated	0.10	0.32	0.59	1.015 (0.279, 1.751)	1.178 (0.748, 1.608)	0.922 (0.743, 1.102)
Sexual identity						
Heterosexual	0.08	0.24	0.68	Ref.	Ref.	Ref.
Bisexual, Lesbian/gay, Other	0.16	0.34	0.50	1.964 (1.052, 2.875)**	1.415 (1.009, 1.820)**	0.737 (0.601, 0.873)**
Has health insurance						
Uninsured	0.11	0.24	0.65	Ref.	Ref.	Ref.
Has health insurance	0.09	0.25	0.66	0.801 (0.199, 1.403)	1.054 (0.534, 1.574)	1.015 (0.814, 1.215)

**Statistically significant (α=0.05)

†All other races includes Asian/Pacific Islander, Native American/Alaskan, other

‡Other includes parents' house, someone else's house/apartment, rooming/boarding/halfway house, shelter/welfare hotel, street, jail/correctional facility, residential drug/alcohol treatment facility, other place.

12: Table - Comparing violence experience across PTSD latent classes among WIHS participants living with HIV

		Probability of being in each PTSD latent class, conditional on predictor level			Risk ratio of being in each PTSD latent class comparing predictor levels (95% confidence interval)		
		High severity	Medium severity	Low severity	High severity	Medium severity	Low severity
Sexual violence	Any experience of sexual violence	0.11	0.31	0.58	1.58 (0.87, 2.28)	1.42 (1.07, 1.76)**	0.82 (0.73, 0.91)**
	Before age 18	0.14	0.33	0.53	1.74 (0.90, 2.57)	1.43 (1.04, 1.82)**	0.77 (0.65, 0.89)**
	By parent	0.09	0.35	0.56	1.04 (0.39, 1.69)	1.49 (1.05, 1.92)**	0.83 (0.69, 0.97)**
	By any family	0.10	0.31	0.60	1.14 (0.54, 1.74)	1.29 (0.93, 1.64)	0.88 (0.76, 1.00)
	By intimate partner	0.10	0.34	0.56	1.17 (0.36, 1.99)	1.40 (0.92, 1.88)	0.83 (0.66, 1.00)**
	By acquaintance	0.20	0.32	0.48	2.43 (1.02, 3.83)**	1.31 (0.77, 1.85)	0.72 (0.52, 0.91)**
	By stranger	0.16	0.32	0.53	2.04 (1.02, 3.06)**	1.30 (0.89, 1.71)	0.78 (0.63, 0.92)**
	By both family member and intimate partner	0.15	0.36	0.49	1.72 (0.22, 3.24)	1.46 (0.73, 2.20)	0.73 (0.46, 1.00)**
	Recent (1 year)	0.11	0.34	0.54	1.33 (0.00, 3.93)	1.39 (0.01, 2.76)	0.82 (0.30, 1.33)
Physical violence	Any experience of physical violence	0.11	0.29	0.60	1.81 (0.93, 2.70)	1.42 (1.05, 1.78)**	0.82 (0.74, 0.90)**
	By parent	0.12	0.30	0.58	1.53 (0.72, 2.34)	1.26 (0.88, 1.63)	0.85 (0.73, 0.98)**
	By any family	0.11	0.32	0.57	1.48 (0.72, 2.24)	1.38 (1.00, 1.76)**	0.82 (0.70, 0.94)**
	By intimate partner	0.12	0.30	0.58	1.89 (1.00, 2.77)	1.43 (1.07, 1.79)**	0.8 (0.71, 0.89)**
	By acquaintance	0.24	0.48	0.29	3.00 (0.69, 5.30)	1.97 (1.06, 2.88)**	0.42 (0.15, 0.70)**
	By stranger	0.06	0.28	0.66	0.74 (0.00, 1.51)	1.12 (0.61, 1.62)	0.99 (0.80, 1.18)
	By both family member and intimate partner	0.12	0.36	0.52	1.54 (0.62, 2.46)	1.54 (1.07, 2.01)**	0.76 (0.61, 0.90)**
	Recent (1 year)	0.33	0.28	0.39	4.31 (1.58, 7.04)**	1.12 (0.32, 1.92)	0.58 (0.28, 0.88)**
Psychological violence	Reported $\geq$1 of 7 partner controlling behaviors*	0.13	0.32	0.56	2.07 (1.13, 3.01)**	1.48 (1.12, 1.85)**	0.77 (0.68, 0.86)**

		Probability of being in each PTSD latent class, conditional on predictor level			Risk ratio of being in each PTSD latent class comparing predictor levels (95% confidence interval)		
		High severity	Medium severity	Low severity	High severity	Medium severity	Low severity
	Reported a previous or current partner has threatened to hurt or kill her, feels her current partner might try to kill her	0.11	0.32	0.57	1.49 (0.82, 2.17)	1.45 (1.10, 1.81)**	0.81 (0.71, 0.90)**
	Recent psychological violence (1 year)**	0.23	0.32	0.44	2.91 (0.50, 5.32)	1.31 (0.42, 2.19)	0.66 (0.33, 0.99)**
Multiple experiences of violence	Physical or sexual abuse by family	0.10	0.30	0.60	1.31 (0.68, 1.94)	1.32 (0.98, 1.66)	0.86 (0.76, 0.96)**
	Physical or sexual abuse by partner	0.11	0.31	0.58	1.68 (0.89, 2.48)	1.54 (1.15, 1.94)**	0.79 (0.71, 0.88)**
	Abuse by family and partner	0.11	0.35	0.54	1.46 (0.69, 2.24)	1.53 (1.10, 1.95)**	0.78 (0.65, 0.90)**
	Participant experienced physical and sexual abuse	0.12	0.30	0.58	1.76 (0.98, 2.55)	1.29 (0.97, 1.62)	0.83 (0.73, 0.93)**
	Participant experienced sexual and psychological abuse	0.15	0.33	0.52	2.12 (1.17, 3.07)**	1.45 (1.08, 1.82)**	0.75 (0.64, 0.85)**
	Participant experienced physical, sexual, and psychological abuse	0.15	0.34	0.51	2.13 (1.16, 3.10)**	1.49 (1.10, 1.88)**	0.73 (0.61, 0.84)**
	Any recent abuse	0.23	0.33	0.44	3.00 (1.07, 4.91)**	1.35 (0.67, 2.03)	0.646 (0.41, 0.89)**

*Seven partner controlling behaviors refers to the following: 1) threatened to be hurt or killed; 2) prevented from leaving house; 3) prevented from seeing friends, 4) prevented from making phone calls; 5) prevented from getting or keeping a job; 6) prevented from continuing education; 7) prevented from seeking medical attention

Paper 2: PTSD symptoms predict worse medication adherence among women living with HIV in a large, national cohort study

Introduction

The number of women living with HIV (WLHIV) in the U.S. is increasing. Women comprise 20% of new HIV cases and 25% of AIDS cases (Centers for Disease Control and Prevention, 2014a). In the U.S. Southeast, women also have higher HIV-related mortality (S. Reif et al., 2014). WLHIV also face a disproportionately high burden of posttraumatic stress disorder (PTSD), a psychiatric disorder that may occur following trauma and is characterized by symptoms that are grouped into hyperarousal, avoidance and numbing (American Psychiatric Association, 2000). A meta-analysis found that 30% of WLHIV have recent (last six months) PTSD compared to 7.8% in the general, U.S. population (Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995b).

Previous studies demonstrate a robust relationship between traumatic events, particularly violence, and poor HIV outcomes including increased risk of death, lower medication adherence, and higher viral load (Leserman et al., 2007; M. J. Mugavero et al., 2009). In particular, the relationship between intimate partner violence and poor HIV care outcomes has been explored in many studies (M. H. Cohen et al., 2004; Hatcher et al., 2015; Leserman et al., 2005; Lichtenstein, 2006; M. Mugavero et al., 2006; M. J. Mugavero et al., 2009; Schafer et al., 2012; Ulett et al., 2009). Childhood sexual assault (CSA) also disproportionately affects PLWH (M. Cohen et al., 2000). CSA is associated with poorer progression through the HIV care continuum (M. H. Cohen et al., 2004; Hatcher et al., 2015; Leserman et al., 2005; Lichtenstein, 2006; Schafer et al., 2012). Despite extensive literature on the relationship between traumatic events and poor HIV care outcomes, little is known about the intervening factors accounting for this

relationship (Kouyoumdjian et al., 2013). One factor that has been associated with HIV risk behavior, and may be one intervening factor, is post-traumatic stress disorder (T. P. Sullivan, Cavanaugh, Buckner, & Edmondson, 2009). Earlier studies suggest it may also be relevant to HIV care outcomes (Pence et al., 2015). PTSD is often caused by the experience of assaultive violence and associated with poor health outcomes in a variety of different illnesses; hence, it may be implicated in the linkage between violence and poor HIV outcomes (Schnurr & Green, 2004).

There is a dearth of literature, however, on the relationship between PTSD and HIV care outcomes despite the clinical implications of PTSD on a wide range of other physical illnesses (Schnurr & Green, 2004). The few studies of PTSD's effect on HIV have contradictory findings (Boarts et al., 2006; Pantalone et al., 2010). To our knowledge, there are ten peer-reviewed studies that examine the relationship between PTSD and at least one of the following HIV outcomes: medication adherence, CD4, and viral load. Seven studies examine medication adherence; of these, five find a negative association, one finds a positive association, and one finds no association. The study finding no association had a context distinct from the others and found a relationship between interruptions in ART supply during Hurricane Katrina's aftermath to be greater among those with PTSD compared to those without (Boarts et al., 2006; Delahanty et al., 2004; A. S. Keuroghlian et al., 2011; Pantalone et al., 2010; Reilly et al., 2009; Sledjeski et al., 2005; Vranceanu et al., 2008). Similarly, seven studies examine the relationship between CD4 and PTSD. Three find no association, three find that CD4 and PTSD are positively associated meaning that more severe PTSD symptoms are associated with higher CD4 counts (Boarts et al., 2006; Delahanty et al., 2004; Kimerling et al., 1999; Klis, Velding, Gidron, & Peterson, 2011; Reilly et al., 2009; Schafer et al., 2012; Sledjeski et al., 2005). One early study

among Black/African-American women finds lower CD4 counts among participants with PTSD (Kimerling et al., 1999). Three studies examined the relationship between viral load and PTSD. Two found no relationship. The last, by Pantalone et al., had a very different methodology from the other studies. It used a structural equation modeling approach that allowed for simultaneously measuring multiple outcomes and easily examining mediation and moderation. This model controlled for trauma exposure and found a relationship between trauma and viral load through PTSD, which suggests that PTSD may be an important factor accounting for the relationship between trauma and poor HIV care outcomes (Pantalone et al., 2010).

Several factors may explain these contradictory findings. Studies with small sample sizes may not be sufficiently powered to detect an effect. Also, cross-sectional designs do not allow for any insight into the direction of association between variables. As each study chose different confounding variables, the interpretation of coefficients of association will differ. For example, some studies do not control for traumatic events, which means that any observed associations between PTSD and HIV outcomes may be due to trauma and not solely PTSD. Furthermore, this set of studies uses differing conceptualizations of trauma, meaning that when analyses do include trauma as a control variable, they may not be including all of the types of trauma that occurred in individuals' lives. Several studies also combine population groups living with HIV who are differently affected by PTSD, for example combining men and women, which may obscure differences in how PTSD operates differently by gender. These studies also use different PTSD measurement instruments and cutoffs. One earlier review of the literature suggested that the use of an abbreviated 4-item PTSD screener may have led to different conclusions across some of these studies (Blashill et al., 2011). Initial models describing the relationships between violence and HIV acquisition and outcomes position PTSD as a mediator between violence and riskier

sexual behaviors (Jewkes, Dunkle, Nduna, & Shai, 2010). A later model by Campbell et al. links PTSD to chronic stress/dysregulated HPA, which is in turn linked to HIV disease progression (Campbell, Lucea, Stockman, & Draughon, 2013). A model focused on the mechanisms of PTSD to all disease outcomes, not only HIV, depicts PTSD as being a predecessor to biological alterations such as a dysregulated HPA, but also to increased health risk behaviors, psychological alterations (e.g., depression), and attentional processes.

We undertook an analysis of the relationship between PTSD and HIV among women living with HIV to explore some of these issues more deeply. Traumatic events are known to lead to poor HIV outcomes, and understanding the extent to which PTSD is responsible could lead to a modifiable target for intervention. First, however, clear evidence of a relationship is needed. Previous work has not been longitudinal, controlled for trauma/violence experience, and used short PTSD measurement tools. This paper aims to improve the way this question is examined by addressing these gaps in the previous literature. Here, we examined the relationship between PTSD symptom severity and these three HIV care outcomes: medication non-adherence, CD4 count, and viral load. Medication non-adherence suggests an impact of PTSD on behavior, and changes in CD4 count and viral load suggest an impact of PTSD on biological indicators. We used data from the Women's Interagency HIV Study, which is a large, ongoing cohort study of women living with HIV. We hypothesize that PTSD may lead to poor HIV outcomes over time and that greater PTSD will be associated with lower CD4 counts, higher viral loads, and medication non-adherence, independent of lifetime traumatic event exposure.

Methods

Data source

This study uses data from the Women's Interagency HIV Study (WIHS), a longitudinal cohort study (WIHS Data Management and Analysis Center, 2016). There are multiple study sites around the U.S., which were selected to be representative of U.S. WLHIV. At each study visit, participants undergo a detailed, structured interview and provide biological samples, which are laboratory tested. Study visits take place every six months. Also, due to local reporting laws, data on violence was not collected from the Los Angeles site. Hence, we did not include data from the Los Angeles site in this manuscript. We used data from blood draws and surveys in this analysis. To be part of the WIHS, participants must self-identify as a woman; be able to consent to participation in the study; consent to participation; be able to complete the interview in English or Spanish; able and willing to travel to research site every six months (sometimes with assistance); be able and willing to participate in the interview and physical examination at the research site; and willing to have blood drawn. Detailed WIHS overviews have been published previously (Bacon et al., 2005; Barkan et al., 1998). This study has approval from the Institutional Review Board at each study site. All participants provided written informed consent once for screening and again for study entry.

This analysis includes the 1,098 participants who opted into a substudy that included a posttraumatic stress disorder (PTSD) measure, the posttraumatic checklist civilian version (PCL-C). The PCL-C was administered for the first time at visit 29 (2008-2009). We used visit data from visit 29 as well as the three subsequent visits – visit 30, visit 31, and visit 32. For clarity, these will subsequently be referred to as baseline, 6 months, 12 months, and 18 months. The study presented here was approved by the WIHS Executive Committee, a representative body including investigators, funders, community members, and study staff, and the JHSPH IRB.

Measures

PTSD symptom measurements were used to derive a 3-class latent class model; the detailed results are described in the previous chapter. In this substudy estimating the relationship between each of the PTSD latent classes and several HIV-related outcomes, we controlled for the following confounders: race, sexual identity, employment, violence experience, and income. These confounders were selected based on prior PTSD research, which points to a higher prevalence of PTSD among those of minority race, minority sexual identity, and lower socioeconomic status (Parto et al., 2011; A. L. Roberts et al., 2011). These factors are also all correlated with HIV-related outcomes, which is why they were included as confounders (Blank et al., 2015; Espino et al., 2015) All measures used are described in detail below.

PTSD latent classes:

We classified participants into three classes by severity of PTSD symptoms using a latent categorical variable: low, medium, and high (see Aim 1 for detailed description of estimating classes). We conducted a latent class analysis to identify subgroups of participants based on PTSD symptom severity at baseline. Previous studies have pointed to clinical cutoffs for the PCL-C as potentially leaving out many individuals with significant impairment due to PTSD (Hellmuth et al., 2014). We found that the best fitting latent class model was a three-class solution where latent classes were a high severity class (9.2%), medium severity class (25.2%), and a low severity class (65.5%) at baseline. The classes did not differ by symptom pattern, only severity, and this analysis has been described in detail in the previous chapter along with its demographic, psychosocial and violence-related factors. The analysis presented here builds on these results. To examine the relationship between latent classes and associated outcomes, we

assigned participants to a class based on the highest membership probability derived in the earlier analysis. If clear class separation is present, and probability of misclassification is low, modal class assignment can be used (Vermunt, 2010). Here, we have an entropy of 0.93 with correct classification probabilities ranging 0.932 to 0.986.

The data used to derive the PTSD latent classes were PTSD symptoms measured using the posttraumatic checklist (PCL-C), a 17-item, 5-point Likert scale (1=not at all, 2=a little bit, 3=moderately, 4=quite a bit, 5=extremely) (Frank W Weathers et al., 1993). Following instructions for scoring this PTSD scale, PTSD symptoms were dichotomized into 3 or greater (symptomatic) vs. 1 or 2 (not symptomatic) (Naomi Breslau et al., 2005; C. Hebenstreit et al., 2014; Steenkamp et al., 2012). In other words, moderately or greater responses were coded as "1" while "a little bit" or "not at all" were coded as "0". Each question, or scale item, corresponds to one of the 17 PTSD symptoms in the DSM-IV (e.g., "Suddenly acting or feeling as if a stressful experience were happening again (as if you were reliving it)?") The scores can range from 17 (answering "not at all" for each item) to 85 (answering "extremely" for each symptom). An important characteristic of the PCL-C is that it questions are phrased to ask about "a" traumatic event rather than "the" traumatic event as other PTSD measurement scales do. This phrasing allows for evaluation of the effects of any traumatic events rather than assuming PTSD symptoms arise from a single trauma. Our earlier study within this population, described in the previous chapter, showed that participants had experienced multiple types and instances of trauma: 42% had experienced sexual violence, and almost half had experienced sexual violence before 18. One-fifth experienced three types of abuse, physical, sexual, and psychological, and 18% had been abused by both a family member and intimate partner.

Previous studies have shown the PCL-C to have strong psychometric properties including test-retest reliability, as well as superior convergent and discriminant validity compared with other measures (Conybeare et al., 2012; Ruggiero et al., 2003; Sherman et al., 2005). PCL-C results closely aligned with other PTSD measurements including the gold standard Clinician-Administered PTSD scale (CAPS) and has been used in studies among people living with HIV (PLWH) (Blanchard et al., 1996; Harrington & Newman, 2007; Katz & Nevid, 2005; Martinez et al., 2002; Sherman et al., 2005; Thames et al., 2012).

HIV Care outcomes:

We examined three HIV care outcomes in this study: detectable viral load, CD4 count <200 cells per μL (consistent with an AIDS diagnosis), and medication non-adherence. We examined these outcomes at the same visit when PTSD was measured (visit 29), as well as three subsequent visits that were 6 months, 12 months, and 18 months following.

- *Detectable viral load (HIV RNA copies per mL):* Viral load was measured using blood samples collected from all participants at visit 29 (concurrent with PTSD measurement), as well as three follow-up visits that were 6 months later, 1 year later, and 18 months later. Viral load was measured using 0.5-1.0 mL aliquots of blood serum (Bacon et al., 2005). Test values can range from 20 to 27,000,000 copies per mL depending on the test used. For this study, we dichotomized viral load into detectable vs. non-detectable, which was below 80 RNA copies per mL in this study to encompass all test types used (Bacon et al., 2005).

- *CD4 count<200 (CD4 cells per μL):* CD4 count, which measures the number of CD4 cells in each microliter of blood, was measured using blood samples collected from all participants at visit 29 and the four subsequent visits, which were 6 months apart. It was measured using 0.5-1.0 mL aliquots of blood serum and CD4 count values ranged from 0 to 9999 cells per μL. For this analysis, CD4 was dichotomized at 200, the threshold for AIDS (Centers for Disease Control and Prevention, 2017a; Lewden et al., 2007).
- *Medication non-adherence*: Participants were asked how often they took antiretroviral medication as prescribed since the previous visit (6 months ago). The answer choices were "100% of the time", "95-99% of the time", "75-94% of the time", "<75% of the time", and "I haven't taken any of my prescribed [antiretroviral] medications." This measure was dichotomized into "100% of the time" and "95-99% of the time" being considered perfect adherence, and the other three responses were considered imperfect adherence similar to earlier analyses from this study (Merenstein et al., 2008). To address social desirability bias, or the tendency to over-report medication adherence, we reverse-coded these responses to no non-adherence vs. some non-adherence where the latter category was comprised of the final three answer choices.
- Violence experience: Violence measures included in this study are any experience of sexual abuse, any experience of serious physical abuse, and any experience of psychological abuse during the participants' lifetime. All three measures were dichotomous. Any experience of sexual abuse was considered an affirmative response to "At any time in your life, has anyone ever pressured or forced you to have sexual contact? By sexual contact I mean them touching your sexual parts, you touching their sexual parts, or sexual intercourse." Similarly any experience of serious physical abuse

was measured by an affirmative response to "Have you ever experienced serious physical violence (physical harm by another person)? By that I mean were you ever hurt by a person using an object or were you ever slapped, hit, punched, or kicked?" Any experience of psychological abuse was considered an affirmative response to having experienced any of the following by an intimate partner: "threatened to hurt or kill you"; "prevented you from leaving or entering your house", "prevented you from seeing friends", "prevented you from making phone calls", "prevented you from getting or keeping a job", "prevented you from continuing your education", and "prevented you from seeking medical attention. Psychological abuse, along with sexual and serious physical abuse, was considered a traumatic experience in these analyses.

Demographic variables: Self-report race, sexual identity, employment, and income were included. Race was categorized as follows: White, Black/African-American, and all other races. All other races grouped together the categories with small sample sizes: Asian-American/Pacific Islander, Native American/Alaskan, and other. Ethnicity was measured as self-identification as Hispanic or non-Hispanic. Sexual identity was dichotomized into heterosexual/straight vs. bisexual or lesbian/gay or other. The last three categories were grouped together due to small sample sizes. Employment and income were also dichotomized into currently employed vs. not and an income of >$18,000 per year vs. less.

Analyses

We present descriptive statistics describing the three HIV outcomes at each of the five time points included in this analysis. We then fit logistic models for all 3 HIV care outcomes

(detectable viral load, CD4 count consistent with AIDS, medication non-adherence). Using the previous literature, theory, and results from our earlier latent class analysis to identify confounders, we determined the following variables should be used as controls: race, sexual identity, employment, income, and any experience of sexual, serious physical, or psychological abuse. When examining CD4 count consistent with AIDS and detectable viral load, we also adjusted for adherence. We fit a total of 12 logistic models: one for each of these 3 HIV outcomes at several time points (PTSD measurement at baseline; HIV outcomes 6 months following, 12 months following, 18 months following). We imputed missing data using multiple imputation by chained equations (MICE) in STATA drawing upon the largely complete sociodemographic data, site at which data were collected, and existing HIV care outcome and violence data to impute the remainder. We cleaned and formatted the data in R; estimated latent classes in MPLUS; and ran the multiple imputation, binomial, and logistic regressions in STATA 15 (Muthén & Muthén, 2006; R Core Team, 2013; StataCorp, 2017).

Results

Study Population

The 934 participants in this study had a mean age of 45.9. The majority of participants were Black/African-American (67.1%), non-Hispanic (79.4%), identified as heterosexual (86.7%), and were born in the U.S. (81.2%). Most did not have employment (62.3%) or a partner (61.5%) but were educated through high school or further (65.7%). Most lived in their own house or apartment (86.1%) and had health insurance (93.8%) (Table 13).

HIV outcomes at each time point

For the 934 participants in this study, only one half had detectable viral loads at baseline, Time 1, Time 2, and Time 3 (range 48% to 51%) with fluctuation between time points (e.g., of those with a detectable viral load at baseline, 25% had an undetectable viral load at Time 3). Mean viral loads ranged from 23,260 to 27,679, which is well above detectability as well as the threshold for transmission (Quinn et al., 2000). Participants' mean CD4 counts ranged from 521 to 543, which is a CD4 count in the clinically normal range. However, between 13% and 15% had a CD4 count of less than 200 cells per μL, which is consistent with an AIDS diagnosis. Also, at each time point, between 19% and 23%had missed 6% or more of their doses according to their own self-report (Table 14).

Relationship between HIV outcomes and PTSD

Tables 14 and 15 show the unadjusted and adjusted odds ratios of each HIV outcome (detectable viral load, CD4 count <200, and medication non-adherence) comparing the medium severity latent class to the low severity latent class and the high severity latent class to the low severity latent class. Participants in the low PTSD class had the highest probability of adhering to ART. When adjusting for violence experience and sociodemographics, the association between class membership and medication adherence is the same or stronger. Specifically, when comparing those with probable membership in the medium vs. low PTSD latent classes, those in the medium PTSD latent class have twice the odds of non-adherence at baseline. Their odds of non-adherence remain high at 72% higher at 6-months follow-up, 57% higher at 12-months follow up, and 66% higher at 18-month follow-up. Participants with probable membership in the high severity class have almost three times higher odds of not adhering to ART at 6, 12, and 18 months follow-up.

Examining the unadjusted odds ratios comparing the high and medium PTSD severity latent classes with the low PTSD latent class, we observe that participants with probable membership in the high PTSD latent class have significantly higher odds of an detectable viral load at Time 1 (OR=1.65, CI=1.02-2.67) and Time 3 (OR=1.9, CI=1.16-3.12). The odds ratio of a detectable viral load did not significantly differ between the medium and low PTSD severity classes except at baseline (Table 15). Controlling for baseline confounding variables (sexual identity, race, employment, income, serious physical, sexual, and psychological abuse), the relationship between PTSD latent class membership at baseline and detectable viral load was no longer statistically significant but, as in the unadjusted model, the odds of having a detectable viral load were lower in the high and medium classes (Table 16).

Participants in the medium or high PTSD severity class at baseline had higher odds of a CD4 count consistent with AIDS (<200 cells per μL) compared to participants in the low PTSD severity class. This difference was statistically significant at one follow-up time point for those in the high PTSD severity class and all follow-up time points for those in the medium PTSD severity class (Table 15). In the adjusted model, the direction of association (higher odds of a CD4<200 cells per microliter) remains but is no longer statistically significant. However, adherence is the one significant predictor of CD4 count in the logistic models at each time point.

Discussion

The results of this analysis point to an association between medium or high severity PTSD latent classes with medication non-adherence, CD4 counts consistent with an AIDS diagnosis (<200), and having a detectable viral load over time. When controlling for sociodemographics and violence experience, the odds ratios comparing medication adherence

between latent classes remained significant with a high magnitude. CD4 and viral load levels between latent classes were not statistically significantly different over time, but in logistic regression models that controlled for adherence, both CD4 and viral load were more significantly predicted by adherence than all other covariates.

We hypothesized that PTSD might be independently related to weaker immune function, which would be detectable in lower CD4 counts. The previous literature examining the relationship between PTSD and CD4 counts is split: three studies find no association between CD4 and PTSD (Boarts et al., 2006; Klis et al., 2011; Reilly et al., 2009) while four do find a relationship albeit in different directions (Delahanty et al., 2004; Kimerling et al., 1999; Schafer et al., 2012; Sledjeski et al., 2005). One study that accounted for trauma exposure found lower CD4 counts among those with PTSD compared to those without. It was a cross-sectional study with African-American woman participants (Kimerling et al., 1999), and our unadjusted findings and population most closely parallel this study. Interestingly, once we adjusted for trauma exposure, we did not observe a relationship between PTSD and CD4 suggesting that the association between trauma and low CD4 count may operate through a route other than PTSD, such as medication adherence.

For viral load, we had hypothesized that more severe PTSD symptoms would be related to higher viral loads. The previous literature is split on this issue as well: two earlier studies did not find a relationship (Boarts et al., 2006; Schafer et al., 2012) while two did (Pantalone et al., 2010; Reilly et al., 2009). We found a higher odds of a detectable viral load at half of the follow-up time points among those in the high PTSD latent class compared to those in the low PTSD class. This result suggests that factors other than PTSD symptoms may account for the observed relationship between PTSD and lower odds of a detectable viral load, such as medication

adherence, which was the strongest predictor of low CD4 count and VL higher than 200 in our models.

We found medication non-adherence to be strongly related to more severe PTSD symptoms, and the prior literature largely parallels this result. Participants in the high and medium latent classes were significantly less likely to report being adherent to their ART regimens and even more so when controlling for confounders. This finding aligns with previous studies that have found a relationship between PTSD symptoms and medication adherence where more intense PTSD symptoms are associated with lower adherence (Boarts et al., 2006; Delahanty et al., 2004; A. S. Keuroghlian et al., 2011; Pantalone et al., 2010; Vranceanu et al., 2008). Given the results of earlier studies, PTSD may be an important target for intervention in improving medication adherence. It may be worthwhile for future studies to examine whether treating PTSD improves medication adherence. In the Schnurr and Green framework describing the pathways through which PTSD affects physical disease outcomes, the pathway would begin with trauma (e.g., violence experience), which would in turn result in PTSD, and the PTSD would then lead to poor health behaviors, such as decreased adherence (Schnurr & Green, 2004). Decreased adherence would, in turn, lead to higher viral loads and lower CD4 counts (Bangsberg et al., 2001; Parienti et al., 2004). Current studies examining treatment of PTSD among PLWH do not examine medication adherence as an outcome (Pacella et al., 2012; Sikkema et al., 2013).

Strengths and Limitations

This paper has several strengths that make it a worthwhile addition to the literature examining PTSD and HIV outcomes. First, this paper has a large sample size (n=934) compared to previous studies whose sample sizes range from 43 to 178). Second, this paper does not use a

cutoff for PTSD, but also considers subclinical levels of PTSD by allowing cutoffs and patterns to originate from the data using latent class analysis. Third, these data are longitudinal while the majority of previous work has been cross-sectional in design, which means that it is possible to make inferences about the sequence in which events occur. Additionally, comparisons between this population and other groups living with HIV may be limited by this population being a slightly older cohort of WLHIV who are stable enough to take part in an ongoing, longitudinal survey. For example, only 40 (4.7%) participants had experienced serious physical or sexual violence in the previous year.

Conclusion

This paper points to a relationship between PTSD and HIV care outcomes including detectable viral load, low CD4 count, and medication non-adherence. When controlling for demographics, medication adherence, and violence experience, only medication non-adherence remained significant in predicting low CD4 count and viral load. Previous studies have consistently found a relationship between PTSD and low medication adherence but have not found the same relationships between PTSD and CD4 and viral load. These results point to implications for practice including reinforcing the importance of trauma-informed care among individuals living with HIV, particularly those with poor HIV care outcomes. It also points to another research question: is adherence a mediator to clinical outcomes? Or, in a program context, does treating PTSD among PLWH lead to improved medication adherence and, in turn, better clinical HIV outcomes? And, if so, which treatment modalities work best? These questions may represent important future mediation analyses.

13: Demographic characteristics of participants at baseline (n=934)

Characteristic		N	%
Age			
	<35	102	10.9%
	36 - 40	129	13.8%
	41 - 45	204	21.8%
	46 - 50	199	21.3%
	51 - 55	167	17.9%
	56+	133	14.2%
Race			
	White	168	18.0%
	Black/African-American	627	67.1%
	All other races (Asian/Pacific Islander, Native American/Alaskan, other)	139	14.9%
Ethnicity			
	Hispanic	192	20.6%
	non-Hispanic	742	79.4%
Country of birth			
	U.S.	758	81.2%
	Puerto Rico or other U.S. territories	32	3.4%
	Other countries	144	15.4%
Currently employed			
	No	582	62.3%
	Yes	352	37.7%
Education			
	No schooling	3	0.3%
	Grades 1-6	12	1.3%
	Grades 7-11	305	32.7%
	Completed high school	278	29.8%
	Some college	263	28.2%
	Completed four years of college	52	5.6%
	Attended or completed graduate school	20	2.1%
Housing			
	Own house or apartment	137	14.7%
	Other	797	85.3%
Income			
	< $6,000	137	14.7%
	$6,001 - $12,000	305	32.7%
	$12,001 - $18,000	116	12.4%
	$18,001 - $24,000	71	7.6%
	$24,001 - $30,000	65	7.0%
	$30,001 - $36,000	52	5.6%

	$36,001 - $75,000	117	12.5%
	> $75,000	67	7.2%
	Missing	4	0.4%
Marital status			
	Legally or common-law married	201	21.5%
	Not married but living with partner	74	7.9%
	Widowed	87	9.3%
	Divorced or annulled	111	11.9%
	Separated	83	8.9%
	Never married	293	31.4%
	Other	84	9.0%
	Missing	1	0.1%
Sexual identity			
	Heterosexual/straight	810	86.7%
	Bisexual, Lesbian/gay, Other	118	12.6%
	Missing	6	0.6%
Has health insurance?			
	No	58	6.2%
	Yes	876	93.8%

14: Viral load, CD4 count, and medication adherence over time across cohort

	Baseline	**Time 1**	**Time 2**	**Time 3**
Viral load (RNA copies per mL)				
mean (range)	23,260 (48-5,775,023)	24,077 (48-34,759)	25,959 (48-4,214,221)	27,679 (2,900-52,457)
Detectable† % (range)	48.4	51.2	48	50
CD4 count (cells per µL)				
mean (range)	521 (0-2075)	523 (3-1921)	534 (0-1923)	543 (2-1773)
CD4 < 200 % (range)	13	12.8	15.1	14.4
Medication non-adherence‡				
%	19.1	19.4	22.8	19.2

†Viral loads below 80 could not be detected.

‡Medication non-adherence was dichotomized at 6%; participants had to be on therapy to be included here

15: Table - Unadjusted odds ratios of HIV outcomes (at each time point) comparing baseline PTSD classes

	Baseline		**Time 1**		**Time 2**		**Time 3**	
	Odds Ratio	CI	Odds Ratio	CI	Odds Ratio	CI	Odds Ratio	CI
Detectable Viral Load								
high PTSD group	1.37	0.86, 2.18	**1.65**	**1.02, 2.67**	1.32	0.82, 2.12	**1.9**	**1.16, 3.12**
medium PTSD group	**1.36**	**1.01, 1.85**	1.31	0.96, 1.79	1.06	0.77, 1.44	1.09	0.8, 1.5
low PTSD group	Ref.	-	Ref.	-	Ref.	-	Ref.	-
CD4<200								
high PTSD group	1.13	0.57, 2.24	0.96	0.44, 2.08	**1.85**	**1.02, 3.39**	1.38	0.71, 2.67
medium PTSD group	1.33	0.86, 2.05	**1.57**	**1.02, 2.4**	**1.87**	**1.24, 2.82**	**1.54**	**1.01, 2.36**
low PTSD group	Ref.	-	Ref.	-	Ref.	-	Ref.	-
Medication non-adherence								
high PTSD group	1.61	0.85, 3.09	**2.86**	**1.61, 5.08**	**2.31**	**1.32, 4.04**	**2.84**	**1.62, 5**
medium PTSD group	**2.08**	**1.38, 3.13**	**1.75**	**1.19, 2.6**	**1.52**	**1.02, 2.27**	**1.54**	**1.01, 2.37**
low PTSD group	Ref.	-	Ref.	-	Ref.	-	Ref.	-

16: Table – Odds ratio of HIV outcomes (at each time point) comparing baseline PTSD classes, adjusted for baseline covariates

	Baseline		**Time 1**		**Time 2**		**Time 3**	
	Odds Ratio	CI	Odds Ratio	CI	Odds Ratio	CI	Odds Ratio	CI
Detectable Viral Load								
high PTSD group	1.05	0.58, 1.89	1.19	0.67, 2.12	0.88	0.49, 1.6	**1.9**	**1.06, 3.41**
medium PTSD group	1.10	0.75, 1.62	1.13	0.77, 1.65	0.8	0.54, 1.2	1.04	0.71, 1.52
low PTSD group	Ref.	-	Ref.	-	Ref.	-	Ref.	-
CD4<200								
high PTSD group	1.1	0.49, 2.5	0.46	0.17, 1.28	1.03	0.46, 2.32	0.83	0.35, 1.97
medium PTSD group	1.17	0.69, 1.99	1.34	0.8, 2.25	1.52	0.91, 2.54	1.38	0.82, 2.33
low PTSD group	Ref.	-	Ref.	-	Ref.	-	Ref.	-
Medication non-adherence								
high PTSD group	1.47	0.75, 2.87	**2.74**	**1.5, 5.02**	**2.47**	**1.37, 4.46**	**3.17**	**1.74, 5.8**
medium PTSD group	**1.96**	**1.28, 3.01**	**1.72**	**1.11, 2.66**	**1.57**	**1.03, 2.39**	**1.66**	**1.07, 2.6**
low PTSD group	Ref.	-	Ref.	-	Ref.	-	Ref.	-

*Control variables include: sexual identity (heterosexual vs. not), race (Black/African-American, white, other), employed (yes/no), income (>18K, <18K), sexual assault (lifetime yes/no), serious physical assault (lifetime yes/no), psychological abuse (lifetime yes/no), and non-adherence for CD4 and viral load

Paper 3: Latent Transition Analysis of PTSD symptoms among WLHIV over time

Introduction

People living with HIV (PLWH) are disproportionately affected by posttraumatic stress disorder (PTSD) when compared to the general population (Safren, Gershuny, & Hendriksen, 2003). In particular, women living with HIV (WLHIV) have a high PTSD prevalence. One meta-analysis found 30% of WLHIV to have recent PTSD (E. L. Machtinger et al., 2012). This group also disproportionately affected by violence and abuse (Brezing et al., 2015; Kouyoumdjian et al., 2013; E. L. Machtinger et al., 2012; Brian Wells Pence et al., 2007; Raja et al., 2015; Siemieniuk et al., 2013; Wyatt et al., 2004). For women living with or at risk of PTSD, access to economic resources has been associated with development and maintenance of PTSD (Golin et al., 2016). Despite the high prevalence of PTSD in this population, almost no research has examined PTSD longitudinally in this context (Blashill et al., 2011). Similarly, the evidence base of interventions to address PTSD in this context is nascent; there have been only two randomized trials to reduce PTSD symptoms among PLWH (Applebaum et al., 2015; McLean & Fitzgerald, 2016).

The vast majority of studies examining the patterns in PTSD over time have taken place among war veterans (e.g., Donoho, Bonanno, Porter, Kearney, & Powell, 2017), but several also exist among civilian groups such as persons affected by disasters, injury survivors, college students, and women experiencing violence (Armour, Shevlin, Elklit, & Mroczek, 2012; Forbes et al., 2015; Read, Wardell, & Colder, 2013; Steenkamp et al., 2008; Wyka, 2013). Of the longitudinal studies focused on civilian women, one focused on 269 substance abuse treatment seekers, 374 women who had experienced sexual assault, 150 another on women seeking

treatment for PTSD, and 91 women who had been abused by male partners (Armour et al., 2012; Blasco-Ros, Sánchez-Lorente, & Martinez, 2010; Cosden, Larsen, Donahue, & Nylund-Gibson, 2015; Shipherd, Clum, Suvak, & Resick, 2014; Steenkamp et al., 2008). These studies found that trauma symptoms decreased over time for most participants, but that there were many for whom symptoms stayed the same or intensified over time. Among those experiencing sexual assault, nearly all participants had an initial high PTSD symptomatology -- there was not a "resilience" class as has typically been found in studies of other types of trauma, (e.g., war) (Steenkamp et al., 2008). A study of 150 women seeking treatment for PTSD did not find changes in health behaviors related to physical health (e.g., exercise, smoking) to be related changes in PTSD symptomatology (Shipherd et al., 2014). Type of trauma was also related to PTSD trajectory. In a study of women experiencing IPV, women experience psychological violence alone did not recover. Those experiencing physical and psychological IPV did recover, and more lifetime traumatic events was related to sustained PTSD symptoms. Ongoing violence, substance use, social support, and food security were also associated with PTSD symptom trajectories in a study among women who had experienced rape and another study of women at risk for HIV/STI (Armour et al., 2012; Golin et al., 2016).

Given the intensity of this problem and gap in the literature, we wanted to explore changes in PTSD severity over time among women living with HIV (WLHIV). This information will be important for planning future programs and setting up care environments designed for this population. Furthermore, WLHIV are a unique population in that not only is this a group managing a complex, chronic disease but is disproportionately affected by PTSD, intimate partner violence (IPV), and childhood sexual assault (CSA) (Brezing et al., 2015; Kouyoumdjian

et al., 2013; E. L. Machtinger et al., 2012; Brian Wells Pence et al., 2007; Raja et al., 2015; Siemieniuk et al., 2013; Wyatt et al., 2004).

We also examine the psychosocial, sociodemographic, and violence-related correlates of any observed changes in PTSD as these may contribute to maintenance of PTSD. Given the results from earlier studies, we hypothesize that PTSD severity will fluctuate over time among WLHIV just as it does for veterans, college students, and women who have experienced violence (Donoho et al., 2017; Read, Bachrach, Wright, & Colder, 2016). We hypothesize that these fluctuations will be related to severity of lifetime violence experience, recency of violence experience, and social and economic resources available to these women. We use latent transition analysis to examine changes in PTSD latent class membership between baseline and a future time point within the two subsequent years. We then examine correlates of each transition.

Methods

Data source

We used data from a longitudinal study of WLHIV called the Women's Interagency HIV Study, or WIHS. It is the largest, ongoing cohort study of women living with HIV in existence. Inclusion criteria for the WIHS include self-identification as a woman; able to consent to participate in the study; consent given to participate in the study; sufficiently proficient in English or Spanish to complete the interview; willing to travel to the research site; and willing to participate in the interview. The Institutional Review Board from each of the WIHS study sites gave its approval. The data presented here represent a group who agreed to take part in a neurocognitive substudy. Participants in this substudy had to be sufficiently proficient in English to take part.

Data from multiple WIHS sites was used: Bronx, NY; Brooklyn, NY; Washington, DC; Los Angeles, CA; San Francisco, CA; Chicago, IL. This analysis uses data from the participant surveys at visit 29 (2008-2009), and visits 30 (6 months later), 31 (12 months later), 32 (18 months later), and 33 (24 months later). Violence data were not collected at the Los Angeles site due to reporting laws, so we did not include any data from the Los Angeles site in analyses using violence variables. We used demographic and violence experience data collected at visit 29 or earlier, and we used PTSD data collected at each of the study visits listed (measures described below). The PTSD instrument was administered to the entire cohort at visit 29, then again over two years with approximately one-quarter of the cohort completing the PTSD measurement at visit 30, visit 31, visit 32, and 33. For this analysis, the PTSD data collected at visit 29 was considered baseline and data collected at visit 30, 31, 32, or 33 was considered Time 1. This analysis was approved by the WIHS Executive Committee, which includes investigators from all sites, funders, community members, and study staff. It was also approved by the JHSPH IRB.

Measures

We measured PTSD using the posttraumatic stress disorder checklist civilian version (PCL-C) and examined relevant demographic and violence experience correlates.

Demographic variables: Demographic variables included were self-reported race (White, Black/African American, and all other categories combined), sexual minority status (heterosexual vs. all other responses), current employment (yes or no), and income (>$18,000 per year or <$18,000 per year) were included. All other races included Asian-American/Pacific Islander, Native American/Alaskan, and other. There were not sufficient numbers of participants in each of these categories to include them separately, so they were combined.

PTSD: We measured PTSD using the posttraumatic checklist (PCL-C), which is a 17-item, 5-point Likert scale (1=not at all, 2=a little bit, 3=moderately, 4=quite a bit, 5=extremely) (Frank W Weathers et al., 1993). Each of the questions in the instrument corresponds to one of the 17 PTSD symptoms as defined in the Diagnostic and Statistical Manual IV (Appendix 1). We dichotomized PTSD symptoms such that 3=moderately or greater responses were coded as "1" while 2=a little bit or 1=not at all were coded as 0. The scores can range from 17 (answering "not at all" for each item) to 85 (answering "extremely" for each symptom).

An important reason for using the PCL-C is that it does not focus on one particular traumatic event as many other validated scales do (National Center for PTSD, 2015c). Instead, its questions are phrased to ask about "a" traumatic event. By doing so, it is possible to evaluate PTSD symptoms resulting from all traumatic events rather than assuming PTSD symptoms arise from a single trauma, which is unlikely in this context. Our earlier study within this population, described in Paper 1, showed that participants had experienced multiple types and instances of trauma: 21% experienced physical, sexual, and psychological, and 18% had been abused by both a family member and intimate partner.

The PCL-C has strong psychometric properties such as high internal consistency, retest reliability, as well as superior convergent and discriminant validity compared with other measures (Conybeare et al., 2012; Ruggiero et al., 2003; Sherman et al., 2005). Earlier psychometric work has shown that PCL-C results closely align with other PTSD measurements including gold standard Clinician-Administered PTSD scale (CAPS) and has been used in this population (Blanchard et al., 1996; Harrington & Newman, 2007; Katz & Nevid, 2005; Martinez et al., 2002; Sherman et al., 2005; Thames et al., 2012).

Violence experience: Recent abuse meant any physical or sexual abuse in the six months prior to visit 28 when these data were last collected. Experience of recent sexual abuse was defined as "pressured or forced to have sex since last visit" and for physical violence "experienced serious physical violence since last visit".

Analysis

Latent transition analysis is an extension of latent class analysis. It extends the grouping of individuals based on a set of characteristics at a single time point to multiple time points. Using this approach, we can examine the stability of latent classes over time, the frequency of transitions between latent classes, and predictors of transitioning between classes (Collins & Lanza, 2010). To determine model structure, we first examined the latent class structure of PTSD data available at baseline (results presented in Paper 1) and at time 1.

We tested each of the combinations of between 3 and 5 classes at each time point. We examined the fit using the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC) for each latent transition analysis model. Using the AIC and BIC, we narrowed the possible models down to four (shown in Table 20). Because these models are not nested, comparing AIC and BIC are the only quantitative measures that can be used to compare among models. Likelihood-based tests cannot be used. After narrowing down to a small number of models with good fit statistics, we re-ran each of these model using ordinal data to choose among them.

We examined whether or not measurement invariance was a reasonable assumption by examining model fits for the best-fitting latent transition analysis models with and without item-response probabilities fixed to the same value at baseline and time 1. We then reported on class

prevalence at each time and the probability of transitions between classes across the two time points by assigning individuals to classes at baseline and time 1 based on modal probability.

Finally, we examined covariates associated with transitions between or stability within classes (Karen Lynn Nylund, 2007). We examined three transitions: a "new disturbance" transition which explored correlates of transitioning from the low to medium or high PTSD latent class; a "maintaining or worsening PTSD" transition from the medium to medium or high class; and a "recovery" transition that examined movement from the high/medium class to the low PTSD disturbance class.

Data cleaning and reshaping was done in R and LTA analyses were done in MPLUS using code available through the appendix of Webnote 15 (Asparouhov & Muthen, 2015; Asparouhov & Muthén, 2014; Hallquist & Wiley, 2017; Muthén & Muthén, 2006; R Core Team, 2013). Logistic regressions to assess covariates associated with transitions were conducted in STATA 15 (StataCorp, 2017). Our analysis consists of those with PTSD data at baseline and follow-up.

Results

Descriptive analysis

PTSD data at baseline and Time 1 were available for 882 participants. Their mean age was 46, and participants were primarily non-Hispanic (81%), African-American (68%) individuals who were born in the U.S. (85%). Most were not employed (63%), had high school or less education (65%), had their own home or apartment (86%), single (63%), and had an income of less than $18,000/year (60%). Most had health insurance (94%). There was a high prevalence of sexual violence (43%), physical violence (54%), and psychological violence (39%)

in this group; 21% had experienced all three types of violence in their lives (Table 17). Among the 882 participants, the percentage of participants with clinically significant levels of PTSD symptoms at baseline ranged from 14%-31% depending on the scoring method used. It was slightly higher at time one: 20%-41% had PTSD (Table 18).

Latent Class Analysis Results

We examined the fit statistics for latent class models at baseline and time 1 with varying numbers of classes (Table19). For both baseline and time 1, the VLMR likelihood ratio test supported a 3-class model while the AIC and BIC supported more classes. Comparing these results with the ordinal models, we chose the 3-class models at both time points. At both baseline and time 1, the best solution had three classes that differed in severity: a low, medium, and high severity class. At baseline, 66% of participants were in the low severity class, 25% in the medium, and 9% in the high severity class. At Time 1, only 53% were in the low class, 28% were in the medium class, and 19% were in the high class (Table 21).

Latent Transition Analysis Results

We tested 16 latent transition models with varying numbers of classes at baseline and time 1 but showed only the four best-fitting models (Table 20). The BIC pointed to a model with 3 classes at baseline and either 3 or 4 classes at time 1. We chose the model with 3 classes at baseline and time 1due to a combination of fit statistics, parsimony, interpretability, and clinical utility. With four classes, some of the trajectories contained <1% of all participants. Of those in the low PTSD class at baseline, 68% remained in the low class, 22% moved into the medium class and 9% moved into the high class. Of those in the medium class, 35% moved into the low PTSD class,

39% remained in the medium class, and 27% moved to the higher class. Of those in the highest PTSD class, 7% moved to the low PTSD class, 27% moved to the medium class, and the majority - or 66% - stayed in the high class. When we tested for measurement invariance, we found that the model assuming identical item response probabilities at baseline and time 1 did not fit the data as well as if we allowed the item response probabilities to vary freely. We proceeded with the model without measurement invariance.

We compared the item response probabilities for the high, medium, and low class at baseline and Time 1 (22). While item response probabilities vary slightly, there is good class separation at baseline and time 1. The item response probabilities mostly overlap but with slightly higher hypervigilance symptom severity at Time 1 for the medium class and slightly lower hypervigilance symptom severity at Time 1 for the high class. There is also very slightly lower re-experiencing symptom severity for the medium class at Time 1 vs. baseline. However, the item response probabilities for each symptom are considerably higher in the high vs. medium class regardless of time point.

Latent Transition Analysis with Covariates

We examined the odds ratios of three transitions: from the low class at baseline to the medium or high class ("new disturbance" transition); from the medium class to the medium or high class ("maintaining or worsening PTSD" transition); and from the high/medium class to low class ("recovery" transition) (Table 24). Examining the new disturbance transition, we find that participants who are Hispanic or identify as bisexual, lesbian/gay or other have an over 70% higher odds ratio of transitioning from low to medium/high compared to those not belonging to these groups. Low socioeconomic status also predicted transitioning to a higher PTSD latent class. Those who are unemployed or have an income of less than $18,000 per year have a 63%

higher odds of transitioning to the medium/high class. Those with less than high school education have twice the odds of transitioning from low to a medium or high PTSD class at time 1. While a history of sexual assault was not found to be associated with this transition, participants with any experience of physical assault had twice the odds of transitioning from the low to medium or high PTSD class, particularly those who were physically abused by a family member (OR=2.36, CI: 1.49-3.76). Physical abuse from an intimate partner did not predict this class transition, while ever experiencing psychological abuse from a partner did (OR=1.72, CI: 1.17-2.54). For participants who already had a subclinical level of PTSD, the only factor predicting maintaining or increasing their PTSD symptom severity was experiencing sexual assault at younger than 18 years of age (OR=2.44, CI: 1.15-5.18). Physical abuse emerged as an important predictor of worsening or maintaining PTSD.

Transitioning from the high or medium PTSD latent class to low, or recovery, was hindered by lack of employment. Unemployed and low-income (<$18,000/year) participants had half the odds of recovery when compared to their counterparts (OR=0.51, CI: 0.29-0.87; OR=0.58, CI: 0.34-0.98). Sexual assault at less than 18 years of age also hindered recovery (OR=0.40, CI: 0.19-0.81).

Discussion

In our sample, PTSD worsened over time as evidenced by an increase in the fraction of participants whose PTSD symptom severity reached levels of clinical significance. Indeed, these data supported a latent transition model with three PTSD classes at baseline and follow-up where more participants experienced transitions to higher classes vs. lower classes. While our model did not support measurement invariance, that is, fixing the item response probabilities to be equal

at each time point, the classes nonetheless show strong separation with higher item response probabilities for each symptom by class. Examining the context of these observed transitions, we found that socioeconomic factors were the strongest modifiable predictors of experiencing PTSD for the first time, specifically employment, income, and education. Other associated factors included ever experiencing physical abuse by a family member, ever experiencing psychological abuse by a partner, Hispanic ethnicity, and identifying as bisexual, lesbian/gay, or other non-heterosexual sexual orientation. Only experiencing sexual assault before 18 years of age was associated with maintaining or worsening PTSD. We also examined factors associated with recovery (moving to the low PTSD latent class) and found similar results: recovery was hindered by lack of income and employment, along with sexual assault before age of 18.

We hypothesized that fluctuations in latent class membership would be related to severity of lifetime violence experience and our analysis suggested that experiencing physical abuse, particularly by family, and sexual assault before the age of 18 influenced worsening symptoms or lack of recovery from severe symptoms. While we hypothesized recent abuse to be related to worsening PTSD, we did not find this association; this may have been because the sample size was too small to detect such an effect. Only 35 (4.0%) of participants reported any recent abuse. Our final hypothesis was that transitions would be related to the social and economic resources available to participants, and our analysis provided strong support for this relationship.

To our knowledge, this is the first study examining changes in posttraumatic stress disorder among individuals living with HIV over time. However, one previous study examined this issue among women at risk for PTSD and found that food insecurity and ongoing abuse predicted PTSD symptoms. Although we did not find an association between ongoing abuse and PTSD, our findings parallel this study in that our results also point to economic hardship as

having a strong, positive relationship with PTSD (Golin et al., 2016). A study from the Millennium Cohort of US service members found a relationship, similar to this study, between education, income, and PTSD trajectories (Bonanno et al., 2012). Most previous studies of PTSD progression among women experiencing violence did not examine contextual factors, such as income(Armour et al., 2012; Blasco-Ros et al., 2010; Cosden et al., 2015; Shipherd et al., 2014; Steenkamp et al., 2008).

This analysis offers one of the first views of PTSD over time among a highly affected population, women living with HIV. Overall, PTSD appears to be increasing over time, and the increases are largely related to socioeconomic factors despite these data being drawn from a population of women stable enough to attend and complete repeated cohort study visits. Classes were generally stable with the majority of those in the high and low classes remaining there, while individuals in the medium or subclinical PTSD class showed significant movement. For those in the medium class with worsening or stable PTSD, only sexual assault before the age of 18 was a predictor. Previous trials and studies have tested successful interventions for childhood sexual assault tailored to women living with or at-risk of HIV. Such interventions may be appropriate for women with HIV and PTSD. An important area for future inquiry as programs to address PTSD among PLWH are developed and tested is whether or not there are differences in those for whom abuse and violence were experienced in childhood. In our study, the violence experiences most associated with worsening PTSD are sexual assault at a young age and physical abuse by a family member (which may have been experienced in childhood as well). Physical or sexual abuse by family had an association with developing PTSD but not abuse from a partner. Overall, physical abuse was more strongly associated with worsening PTSD in this analysis than sexual assault. Earlier studies (including those drawing from this dataset) have shown that both

physical and sexual assault are cause the development of PTSD. This difference in factors associated with changes (or lack of) in PTSD may point to complex, or chronic, trauma affecting some of the participants particularly those experiencing sexual assault in childhood (Roth, Newman, Pelcovitz, van der Kolk, & Mandel, 1997).

For those developing clinical or subclinical PTSD in the time between study visits, the implicated factors include some demographic factors (ethnicity, sexual orientation) and modifiable socioeconomic factors including education, employment, and income. Ethnicity and sexual orientation has been found to be related to PTSD in earlier studies also: previous studies have found higher PTSD rates among ethnic minorities compared to White individuals, and the same is true when comparing sexual minorities with individuals self-identifying as heterosexual (Roberts, Austin, Corliss, Vandermorris, & Koenen, 2010; Roberts et al., 2011). These observed disparities warrant further investigation into the causes of higher observed PTSD among sexual and ethnic minorities in addition to discrimination particularly as the patterns observed here differ from earlier studies where Black/African-American race was most strongly associated with PTSD (McLaughlin, Hatzenbuehler, & Keyes, 2010). In particular, the finding that Hispanic participants more often had worsening PTSD than non-Hispanic participants necessitates further exploration.

Irrespective of the causes, however, PTSD treatments, and programs to address the needs of individuals living with HIV and PTSD, should be tailored to ethnic and sexual minorities. HIV care programs have found success in addressing participants' unmet basic needs, particularly for income and employment, and these approaches may be particularly important not only as solving problems unto themselves but also as a means to prevent developing PTSD among those who are not yet symptomatic. Finally, as earlier studies have stated, the importance

of trauma-informed care cannot be overestimated. The prevalence of PTSD among WLHIV is high, and PTSD fluctuates as presented here;

Strengths and Limitations

This study has several strengths including a longitudinal approach, robust PTSD measure, and large sample size. It also includes socioeconomic factors which have been implicated in the development and maintenance of PTSD (A. L. Roberts et al., 2011). Violence is characterized not only as presence/absence, but also by type, includes psychological abuse, and differentiates between life stage and perpetrator.

Our application of latent transition analysis also included some disadvantages. We measured PTSD at baseline and time 1. At baseline, PTSD was measured for all participants. At each subsequent visit, PTSD was measured for approximately ¼ of the cohort for the four visits after baseline. As a result, time 1 could be 6, 12, 18, or 24 months after baseline depending on the participant. There may be secular trends unique to each group that we are not able to control. Also, because we have only two time points (vs. trajectories with many time points), it is possible that participants do not shift directly from one class to another as our analysis tables imply; participants may in fact experience several shifts in PTSD class between study visits. Other limitations include that we did not look all factors pertinent to the development and maintenance of PTSD, in particular, social support, which many previous studies have shown is an important influencer in PTSD trajectories (Armour et al., 2012; Jain, Latkin, & Davey-Rothwell, 2016). We also did not look at violence at each time point; only in the year prior to the baseline measurement. We did not look at types of trauma other than assaultive violence as these were not collected.

Conclusion

This study suggests that PTSD among women living with HIV is not only highly prevalent, but fluctuates over time. These fluctuations are linked to demographic factors, early violence experience, and ongoing economic security. It is vital for women living with HIV to receive care in trauma-informed care environments, but also gain access to wraparound services either on-site or through partnerships as this may not only help to address economic instability. These wraparound, or social services, should also be trauma-informed. As programs to address PTSD among WLHIV are developed, particular attention should be given to preventing across the life course, particularly in childhood; and working towards economic stability.

17: Table - Participant sociodemographics and violence experience at baseline (n=882)

Characteristic	**N**	**%**
Age		
Mean	46.2	
Range	25-86	
Race		
White	159	18.0%
Black/African-American	603	68.4%
All other races (Asian/Pacific Islander, Native American/Alaskan, other)	120	13.6%
Ethnicity		
Hispanic	164	18.6%
non-Hispanic	718	81.4%
Country of birth		
U.S.	746	84.6%
Puerto Rico or other U.S. territories	19	2.2%
Other countries	117	13.3%
Currently employed		
No	557	63.2%
Yes	325	36.8%
Education		
Middle school or less	306	34.7%
Completed high school	267	30.3%
Some college or more	308	34.9%
Missing	1	0.1%
Housing		
Own house or apartment	756	85.7%
Other	126	14.3%
Income		
< $18,000	530	60.1%
>$18,001	349	39.6%
Missing	3	0.3%
Marital status		
Partnered (legally married, common-law married, living with partner)	253	28.7%
Not partnered (widowed, divorced/annulled, separated, never married)	556	63.0%
Other	72	8.2%

Missing	1	0.1%
Sexual identity		
Heterosexual/straight	761	86.3%
Bisexual, Lesbian/gay, Other	117	13.3%
Missing	4	0.5%
Has health insurance?		
No	49	5.6%
Yes	833	94.4%
Violence experience		
Any experience of sexual violence	327	42.5%
Any experience of physical violence	418	54.4%
Any experience of psychological violence by partner	298	38.8%
Sexual, physical, and psychological violence	163	21.2%
Sexual violence before age 18	152	19.8%
Physical or sexual abuse by family	243	31.6%
Physical or sexual abuse by partner	312	40.6%
Abuse by family and partner	147	19.1%
Recent abuse	35	4.0%

18: Table of PTSD level (by scoring method) at baseline and time 1

	Baseline	**Time 1**
PCL $\geq$ 33	31.0%	41.0%
PCL $\geq$ 44	14.5%	23.8%
Symptom-based	13.8%	20.4%

19: Table describing latent class analysis model fits at baseline and time 1

Baseline					
Model	AIC	BIC	VLMR LRT	p-value	Entropy
2 classes	14186	14007	5280	<0.001	0.948
3 classes	13223	13494	**-6969**	**<0.001**	0.926
4 classes	13045	**13408**	-6559	0.10	0.903
5 classes	12948	**13403**	-6452	0.32	0.877
6 classes	12905	13451	-6385	0.40	0.866
Time 1					
Model	AIC	BIC	VLMR LRT	p-value	Entropy
2 classes	12525	12693	-8334	<0.001	0.939
3 classes	11970	12225	**-6227**	**<0.001**	0.879
4 classes	11867	**12207**	-5932	0.09	0.857
5 classes	11781	**12208**	-5862	0.49	0.833
6 classes	**11747**	12260	-5802	0.34	0.825

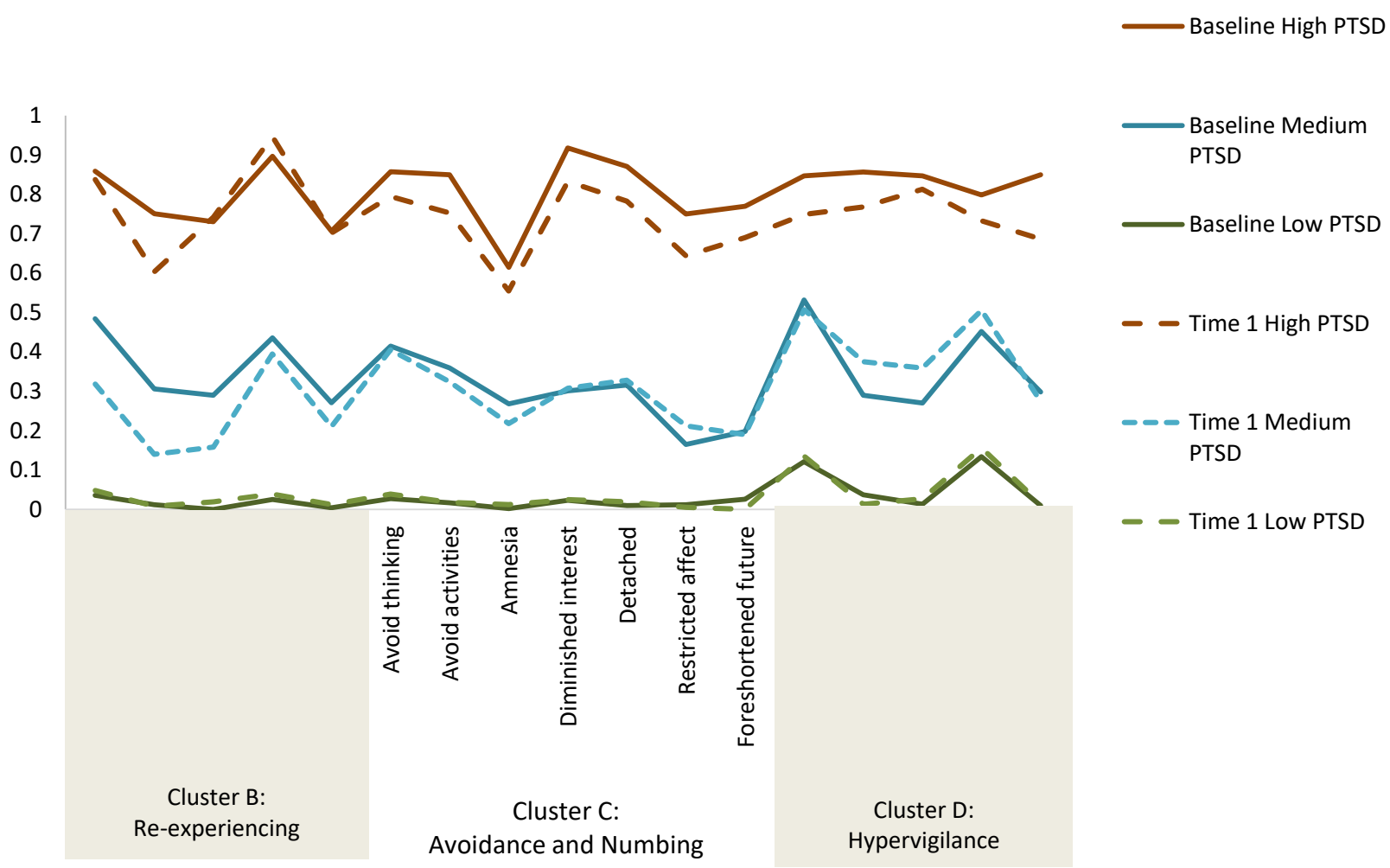
20: Table - Fit Statistics for Latent Transition Models with varying numbers of classes at baseline and time 1

Number of latent classes at baseline	Number of latent classes at time 1	Number of free parameters estimated	AIC	BIC	Log-likelihood
3	3	110	23450	24000	-11615
4	3	130	23272	23922	-11506
3	4	130	23344	23995	-11542
4	4	151	23166	23921	-11432

21: Table - Probabilities of transitions from baseline PTSD classes to time 1 PTSD classes

		Time 1	
Baseline	Low PTSD	Medium PTSD	High PTSD
Low PTSD	68.4%	22.3%	9.3%
Medium PTSD	34.5%	38.9%	26.6%
High PTSD	7.0%	26.7%	66.3%

22: Item Response Probabilities for PTSD latent classes at Baseline and Time 1 (n=882)



24: Table - PTSD class transitions' associations with baseline covariates (n=882)

	Low to Medium/High (New disturbance)		Medium to Medium/High (Maintaining or worsening PTSD)		High/Medium to Low (Recovery)	
	OR	95% CI	OR	95% CI	OR	95% CI
Demographics						
Race						
Black/African-American	0.87	0.55-1.38	0.81	0.39-1.68	1.13	0.57-2.22
All other races†	1.01	0.53-1.92	0.90	0.34-2.38	0.98	0.41-2.34
White	ref.	-	ref. -	-	ref. -	
Ethnicity						
Hispanic	**1.73**	**1.11-2.68**	0.86	0.43-1.72	1.29	0.70-2.38
non-Hispanic	ref.	-	ref.	-	ref.	-
Country of birth						
Outside of U.S. States	0.62	0.37-1.02	0.69	0.30-1.58	1.49	0.72-3.06
Within U.S. States	ref.	-	ref.	-	ref.	-
Employment						
Unemployed	**1.63**	**1.13-2.34**	1.65	0.92-2.98	**0.51**	**0.29-0.87**
Employed	ref.	-	ref.	-	ref.	-
Education						
Less than high school	**2.00**	**1.31-3.04**	1.48	0.75-2.92	0.58	0.31-1.08
High school	1.08	0.69-1.71	1.14	0.57-2.27	0.85	0.46-1.57
College or more	ref.	-	ref.	-	ref.	-
Housing						
Unstably housed	1.07	0.61-1.87	0.79	0.38-1.61	1.42	0.72-2.78

Own house or apartment	ref.	-	ref.	-	ref.	-
Low income						
Income <18K/year	**1.63**	**1.14- 2.35**	1.39	0.78-2.46	**0.58**	**0.34-0.98**
Income ≥18K/year	ref.	-	ref.	-	ref.	-
Marital status						
Has a partner	0.79	0.53-1.17	0.87	0.47-1.63	0.93	0.53-1.64
Single	ref.	-	ref.	-	ref.	-
Sexual identity						
Bisexual, Lesbian/gay, Other	1.71	1.00- 2.95	0.93	0.45-1.91	0.99	0.51-1.89
Heterosexual	ref.	-	ref.	-	ref.	-
Sexual violence victimization						
Ever experienced sexual assault						
Yes	1.41	0.96- 2.06	1.64	0.89-2.99	0.61	0.35-1.07
No	ref.	-	ref.	-	ref.	-
Sexually abused by a family member						
Yes	1.29	0.81-2.05	1.89	0.92-3.88	0.54	0.27-1.07
No	ref.	-	ref.	-	ref.	-
Sexually abused by a partner						
Yes	1.11	0.57-2.17	1.63	0.65-4.09	0.64	0.27-1.54
No	ref.	-	ref.	-	ref.	-
Sexual assault at <18 years of age						
Yes	1.55	0.94-2.53	**2.44**	**1.15- 5.18**	**0.40**	**0.19-0.81**
Physical violence victimization						
Ever experienced physical assault						
Yes	**2.00**	**1.36-2.94**	1.69	0.91-3.13	0.59	0.34-1.04
No	ref.	-	ref.	-	ref.	-
Physically abused by a family member						
Yes	**2.36**	**1.49-3.76**	1.52	0.75-3.11	0.58	0.29- 1.12
No	ref.	-	ref.	-	ref.	-

Physically abused by a partner						
Yes	1.26	0.84-1.87	1.61	0.87- 2.97	0.65	0.37-1.14
No	ref.	-	ref.	-	ref.	-
Psychological violence victimization						
Ever been psychologically abused by partner						
Yes	**1.72**	**1.17-2.54**	1.28	0.70-2.33	0.67	0.39-1.17
No	ref.	-	ref.	-	ref.	-
Experience of multiple violence types						
Physically or sexually abused by partner						
Yes	1.16	0.78-1.73	1.85	0.99-3.44	0.61	0.35-1.08
No	ref.	-	ref.	-	ref.	-
Ever experiencing all three types of abuse: physical, sexual, and psychological						
Yes	**1.84**	**1.14-2.98**	1.41	0.72-2.74	0.70	0.38-1.29
No	ref.	-	ref.	-	ref.	-
Any recent abuse						
Yes	1.18	0.43-3.25	0.94	0.26-3.34	0.74	0.24-2.35
No	ref.	-	ref.	-	ref.	-
Physically or sexually abused by family						
Yes	**1.83**	**1.22-2.76**	1.62	0.85-3.09	0.56	0.31-1.02
No	ref.	-	ref.	-	ref.	-

†All other races includes Asian/Pacific Islander, Native American/Alaskan, other

‡Other includes parents' house, someone else's house/apartment, rooming/boarding/halfway house, shelter/welfare hotel, street, jail/correctional facility, residential drug/alcohol treatment facility, other place.

Discussion

Overview

This dissertation investigates the context, nature, and HIV care outcomes of women suffering from PTSD who are living with HIV using data from an ongoing, longitudinal cohort study. I assessed each of these aims using psychosocial research methods including latent class analysis, latent class regression, latent transition analysis, and logistic regression with multiple imputation using chain equations.

The following section reviews and interprets the findings. It begins with a restatement of each dissertation aim followed by a summary of the research findings and contextualizing the findings in the relevant literature. After summarizing the findings, I share an in-depth exploration of the strengths and weaknesses of this approach to the research aims. I will then describe the implications for future research along this line of inquiry, as well as the how the insights from this dissertation can inform future public health programs and policies.

Summary of findings

Aim 1: To group WLHIV by PTSD symptom severity and investigate the individual and contextual factors describing the group with highest PTSD symptom severity. Aim 1 allows a greater understanding of the contextual factors and challenges faced by WLHIV and PTSD. Specifically, it groups WLHIV into latent classes by PTSD symptom severity and identifies the associated sociodemographic characteristics of women in each group.

This dissertation focused on 1,098 WIHS participants living with HIV for whom PTSD data were available. They were enrolled in this longitudinal study at sites located in Bronx, NY; Brooklyn, NC; District of Columbia; Los Angeles, CA; San Francisco, CA; and Chicago, IL.

The latent class model pointed to three classes (low, medium, and high severity) that differed by symptom severity but not pattern of symptoms. Individuals with probable membership in the high severity class met the diagnostic criteria for PTSD, but many of those with probable membership in the medium severity class did not. Still, the classes were very similar with respect to sociodemographic characteristics associated with PTSD and past violence experience. Contrary to our hypothesis, however, the classes did not differ by symptom type (e.g., avoidance and numbing symptoms) only severity. The violence experienced by each class was also different than our hypothesis: we had hypothesized that most of the participants with severe, multiple violence experiences would be in the same PTSD class. This was not the case. They were distributed between the high and medium classes. We anticipated that one latent class would have few PTSD symptoms, if any, and this was indeed the result.

To our knowledge, this is the first study examining latent classes of PTSD among individuals living with HIV and points to several important considerations for programs and policies related to women living with HIV: subclinical levels of PTSD may be important; similar, severe violence experience exists among individuals with different levels of PTSD; and unmet needs for employment, income, and stable housing are high, particularly among those with subclinical or clinical levels of PTSD. Understanding the prevalence and severity of PTSD in this group, as well as the high levels of unmet basic needs, is particularly important for program planning.

Aim 2: To prospectively examine if PTSD symptoms predict future HIV care outcomes and behavior. Aim 2 quantifies the association between PTSD latent classes and future HIV care outcomes and behaviors (medication non-adherence, CD4<200, detectable viral load).

Aim 2 analyses build off of the three latent classes (high, medium, and low PTSD severity) explicated in Aim 1. We explored the relationship between probable PTSD latent class membership and HIV care outcomes and behaviors. The results of this analysis pointed to an association between PTSD latent class membership and poorer medication adherence, as well as a greater odds of having CD4 counts consistent with an AIDS diagnosis (<200 cells/mL) among those in the high or medium latent classes. In the unadjusted analyses, individuals in the high and medium PTSD latent classes had lower odds of having a suppressed viral load. When controlling for violence experience, medication adherence, and demographic confounders, however, only lower medication adherence was significantly lower when comparing those in the medium and high vs. low PTSD class. This suggests that while those with PTSD are likely to have worse CD4 counts and viral load, PTSD symptoms may link violence experience to poorer HIV outcomes through medication adherence. ART adherence was the most significant predictor of viral load and CD4 in the logistic regressions.

Aim 3: To test whether current PTSD latent classes remain stable over time. Aim 3 examines whether probable membership in PTSD latent classes at one time remains consistent over time using latent transition analysis and quantifies associated factors.

Aim 3 examines whether the latent classes, modeled in Aim 1 and explored in Aim 2, stay consistent over time. Using latent class analysis, we found that the classes are not stable over time; there is a great deal of shift between classes with the greatest movement from lower to higher classes. Specifically, the majority of those in the medium PTSD class at baseline stayed in the medium class or moved to the high PTSD class (66%) and nearly all of those in the high PTSD class were in the medium or high class at follow-up (93%). Almost one third of those in

the low PTSD class moved to the medium or high class (32%). Sociodemographic factors associated with maintaining or worsening PTSD included ethnicity, unemployment, and low income. Violence-related factors included sexual assault at less than 18 years of age, ever experienced serious physical assault, ever seriously physically abused by a family member, psychological abuse by a partner, physical or sexual abuse by a partner, experience of all three abuse types (physical, sexual, and psychological), or physical and sexual abuse by family.

Our hypothesis that probable PTSD latent class membership would fluctuate over time was borne out by our model. Similarly, our hypotheses that these transitions would be related to lifetime violence experience, as well as available social and economic resources, was also borne out by the model. We did not find that recency of violence was a significant predictor of class transition as we had hypothesized. This result is inconclusive, however, as the lack of relationship may be due to the small number of individuals experiencing recent violence in this study (n=35).

The implications of sociodemographic factors – specifically unemployment and low income – further underscore the findings from Aim 1, which pointed to high levels of unmet need among participants living with HIV and PTSD. These insights point to a risk of worsening PTSD among those with low resources, which is an issue that can be addressed by programs. Examining violence experience also extends the analyses from Aim 1 by further elucidating the types of violence experience associated with maintenance or worsening PTSD.

Limitations and Strengths

Strengths of the study design

There are many strengths of this study that are worthwhile to note. This study uses a larger sample size than many, previous studies examining PTSD among PLWH. It also uses longitudinal data, which can provides more insight than the cross-sectional designs used by most studies in this topic area to date. The WIHS takes place in a setting specific to a study. This design is in contrast to clinic studies that include only those linked or retained in care. Interval studies, or ongoing cohort studies, also have detailed measures administered identically across participants and visits, which may not be possible in clinic-based study designs. In addition, because the WIHS takes place outside of a medical setting, participants may be more likely to report behaviors that they would hesitate to share with clinical staff (e.g., medication non-adherence). Also, clinic-based settings may not allow adequate time to administer the extensive sociodemographic, psychosocial, and psychiatric information needed for these proposed research questions (Lau, Gange, & Moore, 2007). This has several advantages: first, it does not limit the study population to those accessing medical care. Second, data collectors for the study built relationships with participants over time, and participants may provide more candid responses to queries from study data collectors than medical professionals.

Our study also uses a PTSD measure - the posttraumatic checklist (PCL-C) - that has strong psychometric properties. Some previous studies have used abbreviated scales, which may have contributed to the contradictory findings in the literature (Blashill et al., 2011). The WIHS also collects extensive sociodemographic and psychosocial variables. Another strength of the parent study is its high study retention: early loss to follow-up was only 10% in the original cohort and 5% in the 2001-2 cohort and over 80% 12 years into the study among WLHIV (Bacon et al., 2005; WIHS Data Management and Analysis Center, 2016).

Strengths of the analytic approach

The strengths of this analytic approach include applying relatively new psychosocial statistical methods to understanding a complex pathway and exploring the interrelationships of PTSD, violence, and social determinants in a large, national dataset. These methods allow PTSD symptom severity to be conceptualized as groups arising from the data, rather than forcing the researcher to choose an arbitrary cutoff. The three-step processes used in this dissertation also allow uncertainty of class membership to be incorporated into the models.

This dissertation also draws upon theory including the pathways between PTSD and poor physical health created by Dr. Paula Schnurr and the linkages between social factors and mental illness by Dr. Sandro Galea at multiple levels, similar to the socioecological model (Centers for Disease Control and Prevention, 2015b; Cottler, 2011; Wolf & Schnurr, 2016). Interpreting the results presented here through the Schnurr and Green model, our results point to a pathway from trauma to PTSD to health behavior (particularly adherence) and poorer HIV care outcomes. Examining these results in their sociocultural context is aided by Galea's model. At the individual level, we see race, ethnicity, and sexual orientation as playing important roles in the development and persistence of PTSD among WLHIV. At the macrosocial levels, we observe the importance of factors such as violence experience and its characteristics including perpetrator. At this level, income, employment and housing stability also emerge as important factors. These are, at least in part, determined by macrosocial processes such as the availability and pricing of housing, requirements for housing programs, availability of employment opportunities, wages offered by employment opportunities, etc. The Galea model also points to an important shortcoming in our research, which that we did not examine factors at the molecular level. Still, this research contributes to this conversation by examining the appropriateness of

PTSD as a potential target for intervention to improve care outcomes for PLWH supported by a nuanced exploration and discussion of its context (Khanna, 2012; E L Machtinger, Haberer, Wilson, & Weiss, 2012; ONAP, 2015).

Limitations

Alongside the strengths described above, this research has several limitations: the PTSD measure used is a self-report of symptom severity and not the gold-standard for diagnosing PTSD, which is the hour-long Clinician-Administered PTSD Scale (CAPS) (National Center for PTSD, 2015a). Second, this study measures PTSD rather than complex PTSD (cPTSD). PTSD is understood as a reaction to a single traumatic event (American Psychiatric Association, 2000). Complex PTSD is a somewhat different psychiatric condition. It arises from repeated, chronic trauma and is distinct from PTSD (Herman, 1997). However, few widely-used and validated cPTSD measures are available, and 92% of individuals with cPTSD meet diagnostic criteria for PTSD ("Complex PTSD - PTSD: National Center for PTSD," 2016). In this research, one-fifth of participants had experienced all three types of violence measured (physical, sexual, emotional) meaning that complex PTSD may be a more relevant concept than PTSD. Similarly, the third aim pointed to an association between sexual assault before age 18 and maintaining or worsening PTSD. Together, these findings point to a need to examine not only PTSD in this population but also complex PTSD. There are fewer tools to examine complex PTSD, however, as it is not included in the Diagnostic and Statistical Manual (American Psychiatric Association, 2000). Also, it was not added to the recent update of the Diagnostic and Statistical Manual despite a great deal of evidence and expert discussion (American Psychiatric Association, 2013b; Friedman, 2013).

Third, the proposed research did not include potential physiological mediators (e.g., hypothalamic–pituitary–adrenal axis) because these are not collected in the parent study, and work in progress suggests that physiological factors may play an important role in the relationship between violence and HIV care outcomes (Anderson, Glass, Farley, & Campbell, 2016). While physiological mediators could not be examined here, there is nascent work within the WIHS that collects and uses data on physiological mediators (Mardge Cohen, personal communication, 2017). Fifth, genetics play an increasingly well-understood role in development of PTSD but could not be examined here (Duncan et al., 2017). Additionally, the relationship between PTSD and HIV care continuum outcomes – linkage and retention in care – is not well-understood. Data on engagement in care were not available in the dataset used in this paper but are important for building the evidence base to address PTSD among PLWH. Other important factors in the relationship between PTSD and HIV care outcomes include various types of substance use, but less than 2% of all study participants reported any recent substance use; hence, these variables were not included in this analysis (Table5).

Generalizability

The women participating in the WIHS may differ somewhat from the overall population of WLHIV in the U.S. WIHS participants are a relatively stable group as they have the ability to attend study visits twice annually. WIHS participants also receive linkage to social services through their engagement with the study. While these characteristics of the study population may limit generalizability, it is extremely difficult to collect longitudinal data from individuals who are unable to attend multiple study appointments over time. In particular, it is very difficult and resource-intensive to collect viral load and CD4 data for which a blood draw is needed. WIHS

participants do have a variety of HIV-related health outcomes and are not necessarily all receiving HIV care. Many do not have suppressed viral loads or CD4 counts above 200 according to the analyses results presented in Paper 2 (Table 14). Furthermore, the participants within the WIHS who participated in the neurocognitive substudy (from which PTSD data are drawn) differ from the participants in the overall study – they are more likely to be born in a U.S. state and more likely to be stably housed. These differences imply that in a broader sample of WLHIV, who do not share these advantages, unmet basic needs (e.g., for housing) are very likely to be higher. Therefore, the relationships between sociodemographic characteristics and health outcomes presented here may be underestimates. The greater likelihood of being born in a U.S. state may be related to the requirement that neurocognitive substudy surveys be completed in English. Despite its limitations, this study provides important insights into the causes, trajectory, and potential solutions to the high PTSD prevalence among women living with HIV.

Research Implications

As described in the introduction of this dissertation, there is a clear, pressing need for testing interventions that address PTSD among PLWH, and the results of the research presented here may help to design effective interventions. There is a paucity of such interventions, and those that exist primarily use cognitive behavioral therapy approaches. (Applebaum et al., 2015). Novel approaches, such as somatic or body-based therapies (as opposed to cognitively-focused approaches) to reduce PTSD, have shown promise in the general population and could be tested in this context (van der Kolk, 2014). Older approaches, such as Written Exposure Therapy, may also be promising in this context (Sloan, Marx, & Resick, 2016). These approaches should ideally be scalable, cost-effective, and tailored to PLWH. It is worthwhile to note that

interventions to address complex PTSD, or PTSD resulting from prolonged or early-life trauma, may be worth prioritizing in this context. The results of this research and earlier research points to many traumatic experiences in this population, not one experience in a lifetime (Decker et al., 2016). Earlier research suggests different interventions are needed in cases with prolonged or early-life traumatic experience (de Vries, 2008). This is a challenging line of inquiry to pursue given that complex PTSD, while recognized by experts in the field, is not included in the DSM-V (American Psychiatric Association, 2013b).

As these interventions as being tested, their effect on the HIV care continuum should also be included as outcomes along with PTSD. The implications of these studies would enhance treatment design not only for PLWH, but also other populations affected by PTSD such as veterans and women experiencing violence. Medication as an intervention for PTSD may also be considered, but it is worthwhile to note that a previous, randomized study addressing depression using medication among PLWH did not find improvements (Pence et al., 2015). One reason the authors cite for not finding a connection is that other mental health issues, such as PTSD, were not addressed. A deeper, more specific understanding of the mechanisms connecting traumatic events to poor HIV outcomes may enhance the effectiveness of interventions that are effective in improving HIV continuum of care outcomes. Additionally, results from this dissertation and others point to the salience of unmet basic needs in the context of HIV care outcomes. Interventions that address only mental health symptoms without addressing exacerbating factors, such as unmet basic needs or past trauma, may not be successful in altering HIV outcomes and may be less successful in decreasing PTSD than interventions coupled with tailored social services.

Another contribution of this study is examining the sociodemographic context of women living with HIV and PTSD. Earlier studies of PTSD thoroughly examine the relationship between PTSD and traumatic events (type, characteristics, duration), but may benefit from including sociocultural context (e.g., housing stability, income). Including sociocultural context in future work would help to gain a deeper understanding of how these factors are related to PTSD and poor HIV outcomes. Since very little is known or understood about the sociocultural context of women living with HIV and PTSD, further descriptive or exploratory research may be appropriate. In particular, qualitative research may be a worthwhile approach to examine factors outside of those included in data that has already been collected or factors already deemed to be important through research.

Understanding the pathways from which trauma leads to poor HIV care outcomes (other than the direct connections) is not yet well-elucidated, and qualitative or mixed-methods approaches may be helpful in this context. It may also help to elucidate the mechanisms through which sociocultural context and health outcomes are associated with PTSD among PLWH. These additions to the study and treatment design for PTSD would benefit not only WLHIV, but men and trans individuals living with HIV as well as veterans who are affected by PTSD.

The results of this dissertation also point to a disproportionate representation of sexual minority women among those with severe PTSD. In Aim 1, a sexual minority status was associated with more severe PTSD, and in Aim 3, sexual minority status was associated with transitioning from the low to high PTSD latent class. While this study has relatively few participants identifying as a sexual minority (n=143), but an in-depth examination of differences between these individuals and those identifying as heterosexual may build the knowledge base about unique challenges faced by sexual minority women in terms of HIV and PTSD. It may also

help to begin to understand how future programs should be adapted and tailored to be appropriate for sexual minority clients or patients.

Given that the population in this study was relatively stable and represents an adult population (with a mean age of 45.9), it is important to examine PTSD among other populations who not able to access HIV services, such as newly diagnosed individuals, younger adults, adolescents with PTSD, and community-based samples of women. Other groups impacted by violence and trauma should also be included in similar studies, particularly young MSM of color, for whom the HIV epidemic has not yet slowed (Singh, Song, Johnson, McCray, & Hall, 2017). This study sample is among individuals who self-identified as women, but no data were collected on birth sex. There was also no deliberate inclusion of women of trans experience. Exploring the connections between HIV and PTSD among individuals with trans experience is also an important direction for future research given that transwomen, in particular, are also disproportionately and adversely affected by PTSD (Baral et al., 2013). Many members of each of these groups are adversely affected by HIV and trauma and exploring the impact of PTSD on their lives is a worthwhile, future area of inquiry.

Also, these data did not include the U.S. South, where the HIV epidemic is at its most severe in the nation (CDC: National Center for HIV/AIDS, Viral Hepatitis, STD, 2016). The WIHS recently added four sites in the U.S. Southeast; these same analyses could take place among this likely younger cohort living in a setting associated with greater HIV risk and worse HIV care outcomes (WIHS Data Management and Analysis Center, 2016).

Program and Policy Implications

This research has important insights for policy development as this research explores an urgent public health problem and reflects policy priorities articulated in the updated National HIV/AIDS Strategy (NHAS) 2015-2020. Step 2 of the document calls for: "2.C.2: *Improv[ing] outcomes for women in HIV care by addressing violence and trauma,* and factors that increase risk of violence for women and girls living with HIV." These goals were blended into the larger, national HIV agenda from the U.S. Federal Interagency Working Group on the Intersection of HIV/AIDS, Violence against Women and Girls, and Gender-Related Health Disparities (ONAP, 2015).

More broadly, addressing this issue also requires addressing its key causes, one of which is violence. Assaultive violence is also a well-established cause of PTSD that could be addressed in programs for PLWH through strategies for preventing further violence and addressing ongoing violence. Adopting evidence-based violence prevention approaches for at-risk individuals across the life course is critical. Intimate partner violence and sexual violence, in particular, should be focal points for violence prevention. Several evidence-based programs exist already (Centers for Disease Control and Prevention, 2017c). While reducing the threat of violence may lead to lower rates of PTSD, secondary prevention is would also have a positive impact on this public health issue. Interventions to prevent PTSD exist and could be tailored to and implemented in at-risk communities (Kearns, Ressler, Zatzick, & Rothbaum, 2012).

This dissertation research not only underscores the importance of this agenda but points to the importance of tailoring services to individuals with significant trauma in their lives. Given the high prevalence of trauma, individuals receiving HIV services would ideally receive care in a trauma-informed care environment. Many earlier groups, including advocacy groups for

WLHIV, have called for trauma-informed care and models have been defined (Adams et al., 2016). Similar research and examination of PTSD treatment that is appropriate for the communities affected by HIV that would be receiving care in these environments and well-tolerated is an appropriate next step. Both care for HIV and PTSD should be supported by thorough social services interventions to address the unmet basic needs (housing, employment, education, food) that hinder improved health in terms of HIV and PTSD. The current, high level of unmet basic need among women living with HIV and PTSD may be placing them at risk for worsening PTSD.

Several of these recommendations already have support and guidance from other contexts that can be applied here. The HHS agency, Substance Abuse and Mental Health Services Administration (SAMHSA), has a strong focus on trauma-informed care through its center dedicated to this issue. The National Center for Trauma Informed Care and Alternatives to Seclusion and Restraint (NCTIC) provides guidelines technical assistance on trauma-informed care to the types of agencies relevant for many U.S. PLWH: community-based behavioral health agencies, homeless service providers, HIV service providers, and domestic violence organizations (Substance Abuse and Mental Health Services Administration, 2014, 2017).

To give a specific example, in January 2018, SAMHSA posted a request for proposals for programs integrating mental health and substance abuse treatment into HIV primary care and prevention (Substance Abuse and Mental Health Services Organization, 2018). The RFP has many strengths including that all grantees are required to use evidence-based programs and include case management services that provide linkages to services such as housing, benefits, and employment. This program also provides relatively long-term funding of 4 years and requires programming to be tailored ethnic minority populations. Incorporating the findings of

this dissertation, this grant portfolio may benefit from tailoring its programs to sexual minority communities in addition to ethnic minority communities; requiring that HIV care be administered in a trauma-informed context; address prevention of violence; offer strategies to address ongoing violence; and include a research or evaluation component. The results of this grant portfolio could bridge many critical gaps in the field. There are few studies examining reducing PTSD among PLWH and how changing mental health is linked to HIV care outcomes. In this grant portfolio, opportunities to collect data on mental health and HIV outcomes over some portion of four years exist. This represents an ideal opportunity to understand changes over time in mental health and HIV outcomes in the context of a program designed to address both of these issues with the best available evidence in a context where participants' basic needs (housing, employment) are also being addressed.

Conclusion

The prevalence of HIV among women in the U.S. is increasing, and this population is also disproportionately affected by PTSD. It is critical to understand this overlap and design programs and policies that can address PTSD in this population. In this dissertation, I examined the prevalence, severity, and manifestation of PTSD in a group of U.S. women living with HIV. I also examined their violence experiences, sociodemographic contexts, HIV outcomes as related to PTSD symptomology, and constancy of PTSD symptoms. PTSD is highly prevalent even among groups not experiencing ongoing violence and is strongly related to a set of sociodemographic factors. Evidence-based interventions to manage and treat PTSD where WLHIV seek services are needed but the research remains nascent. This represents a pressing area of further inquiry about an urgent public health issue.

Appendix 1: Posttraumatic Checklist

25: Table - DSM-IV posttraumatic stress disorder items, symptoms, and clusters

Item/Symptom number	Symptom (DSM-IV)	Corresponding symptom cluster	Item (PCL)
1	Recurrent and intrusive distressing recollections of the event, including images, thoughts or perceptions	B – Re-experiencing	Repeated, disturbing, and unwanted memories of a stressful experience from the past?
2	Recurrent distressing dreams of the event;	B – Re-experiencing	Repeated, disturbing dreams of a stressful experience from the past?
3	Acting or feeling as if the traumatic event were recurring (e.g. reliving the experience, illusions, hallucinations, and dissociative flashback episodes, including those on wakening or when intoxicated);	B – Re-experiencing	Suddenly acting or feeling as if a stressful experience were happening again (as if you were reliving it)?
4	Intense psychological distress at exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event;	B – Re-experiencing	Feeling very upset when something reminded you of a stressful experience from the past?
5	Physiological reactivity on exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event.	B – Re-experiencing	Having physical reactions (e.g., heart pounding, trouble breathing, sweating) when something reminded you of a stressful experience from the past?
6	Efforts to avoid thoughts, feelings or conversations	C - Avoidance	Avoiding thinking about or talking about a stressful

Item/Symptom number	Symptom (DSM-IV)	Corresponding symptom cluster	Item (PCL)
	associated with the trauma;		experience from the past or avoiding having feelings related to it?
7	Efforts to avoid activities, places or people that arouse recollections of this trauma;	C - Avoidance	Avoiding activities or situations because they reminded you of a stressful experience from the past?
8	Inability to recall an important aspect of the trauma;	C - Avoidance	Trouble remembering important parts of a stressful experience from the past?
9	Markedly diminished interest or participation in significant activities;	C - Avoidance	Loss of interest in activities that you used to enjoy?
10	Feeling of detachment or estrangement from others;	C - Avoidance	Feeling distant or cut off from other people?
11	Restricted range of affect	C - Avoidance	Feeling emotionally numb or being unable to have loving feelings for those close to you?
12	Sense of a foreshortened future	C - Avoidance	Feeling as if your future will somehow be cut short?
13	Difficulty falling or staying asleep	D – Hyperarousal	Trouble falling or staying asleep?
14	Irritability or outbursts of anger	D – Hyperarousal	Feeling irritable or having angry outbursts?
15	Difficulty concentrating	D - Hyperarousal	Having difficulty concentrating?
16	Hypervigilance	D - Hyperarousal	Being "super-alert" or watchful or on guard?
17	Exaggerated startle response	D - Hyperarousal	Feeling jumpy or easily startled?

Appendix 2: Additional analyses to support choice of 3-class model in Aim 1

This appendix provides deeper insight into the latent class analysis conducted for Aim 1. Specifically, it illustrates factors considered in the choice of a 3 vs. 4 or 5-class model that could not fit into the Aim 1 manuscript. When testing latent class models with differing numbers of classes, we found the following fit statistics:

26: Table - Fit statistics of latent class models (referenced from Aim 1 paper)

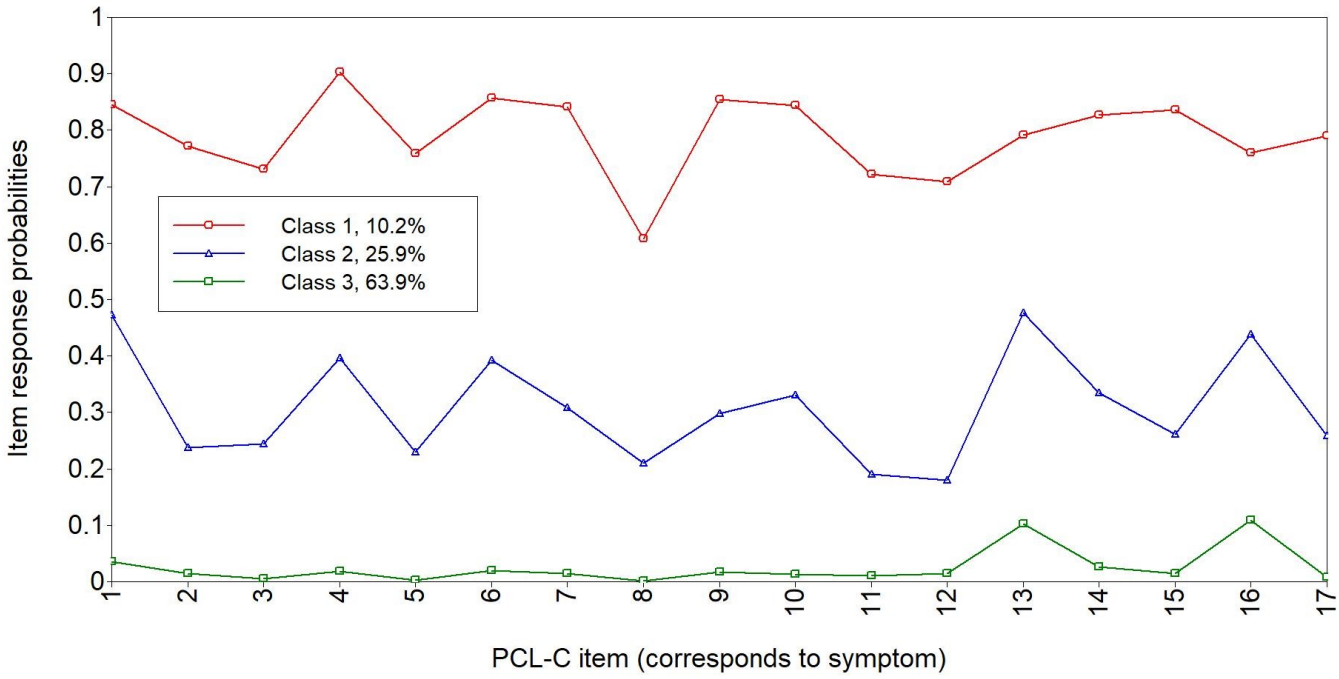
Model	BIC	AIC	VLMR LRT	p-value	Entropy
2-class	12,740	12,565	4,709	0.00	0.95
3-class	**12,144**	11,879	**722**	**0.00**	0.93
4-class	**12,061**	11,705	209	0.09	0.91
5-class	**12,069**	11,624	117	0.34	0.87
6-class	12,110	**11,575**	85	0.19	0.89

Notes: Bold numbers correspond to the number of classes suggested by the criterion. BIC=Bayesian Information Criterion; AIC=Akaike Information Criterion; VLMR LRT=Vuong-Lo-Mendel-Rubin LRT; BLMR LRT=Bootstrapped Lo-Mendel-Rubin LRT

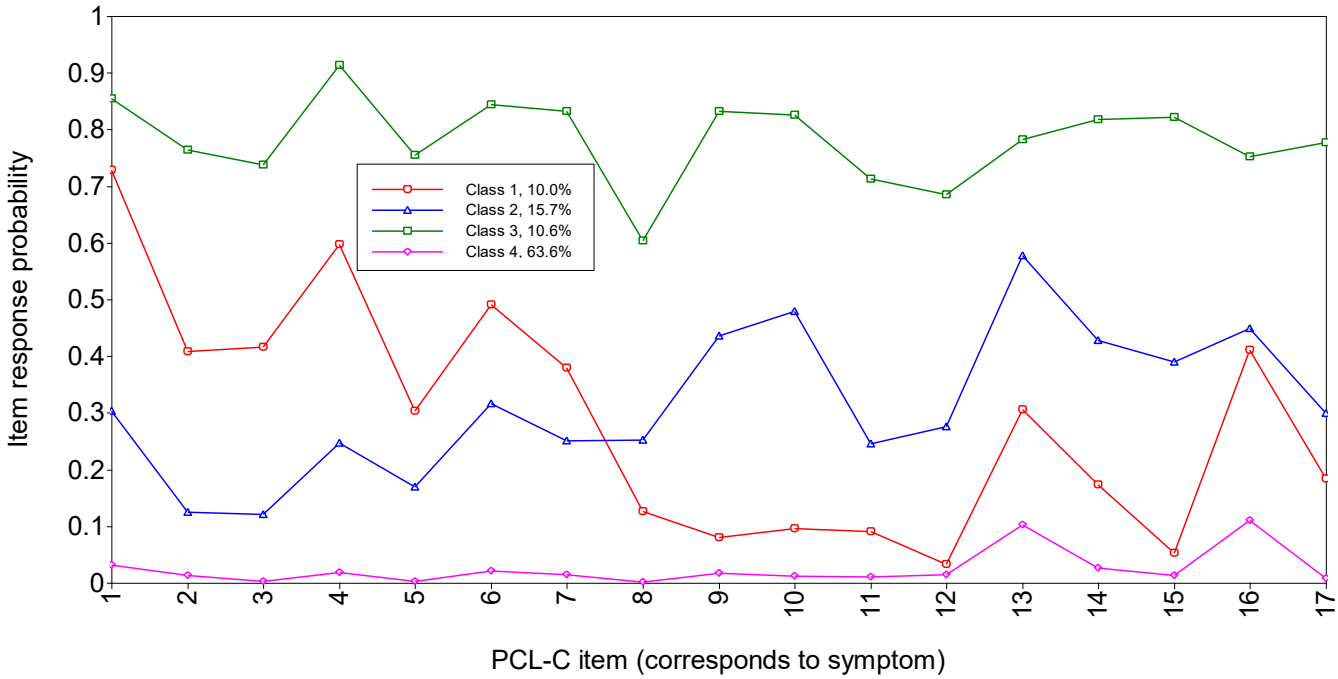
The BIC best supports a 3, 4, or 5 class model while the AIC best supports a 6-class model. The likelihood ratio test based methods, however, do not support a model larger than a 3-class model. The probable item endorsement patterns categorizing the classes in the 4-class model had meaningful, qualitative differences not observed in the 3-class model where each class differed based only on symptom severity.

Below are charts illustrating the item-response probability patterns in the 3- and 4-class models:

27: Figure - Item response probabilities in 3-class LCA, by class



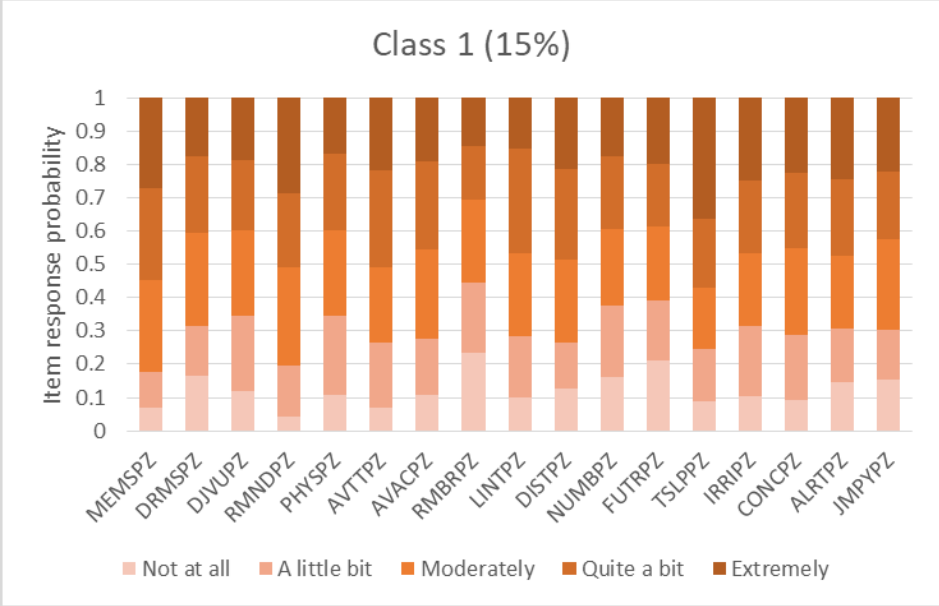
28: Figure - Item response probabilities in 4-class LCA, by class



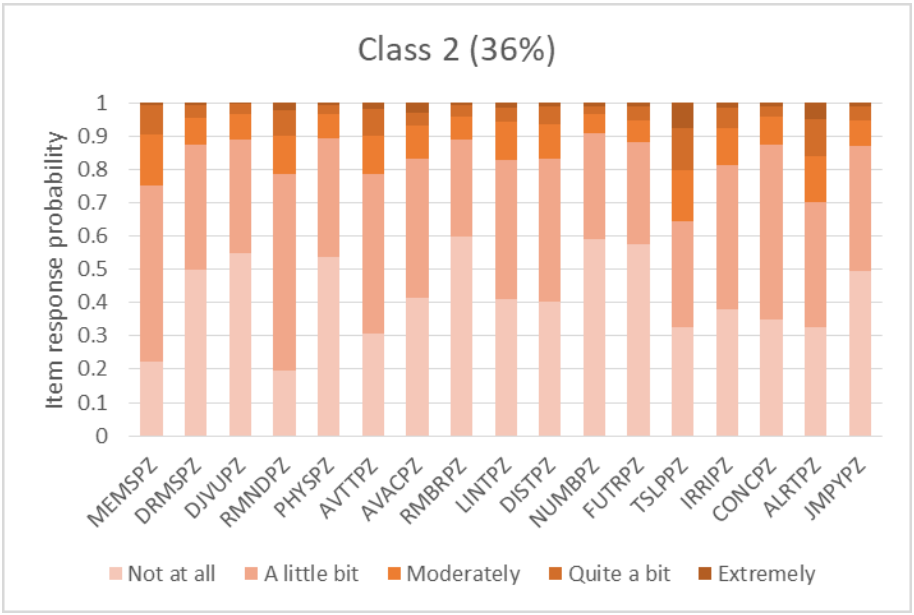
Examining each of these models using ordinal – rather than binary – data from the PCL-C, we find the following:

3-class model:

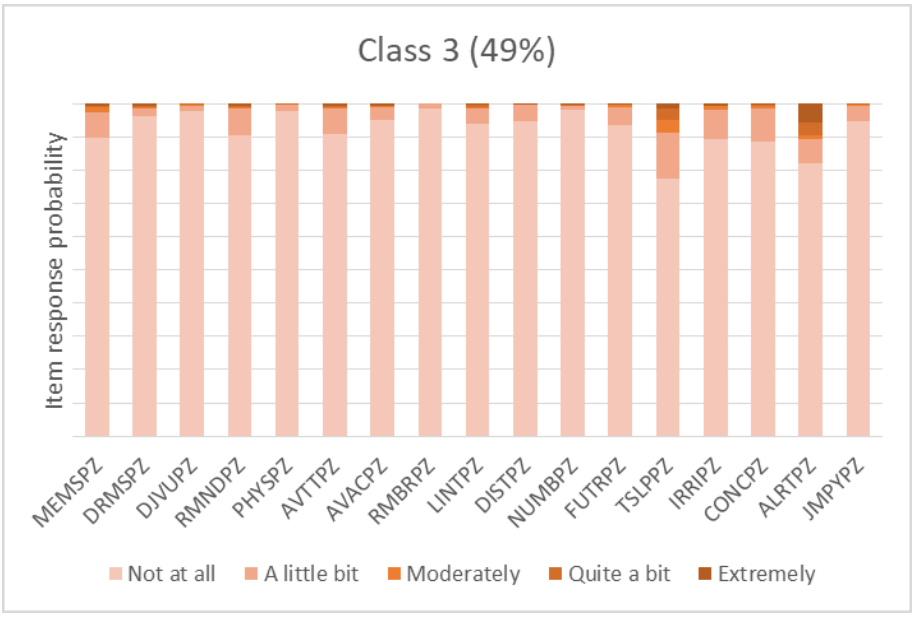
29: Figure – High PTSD severity class using ordinal PCL-C responses (3-class LCA)



30: Figure – Medium PTSD severity class using ordinal PCL-C responses (3-class LCA)

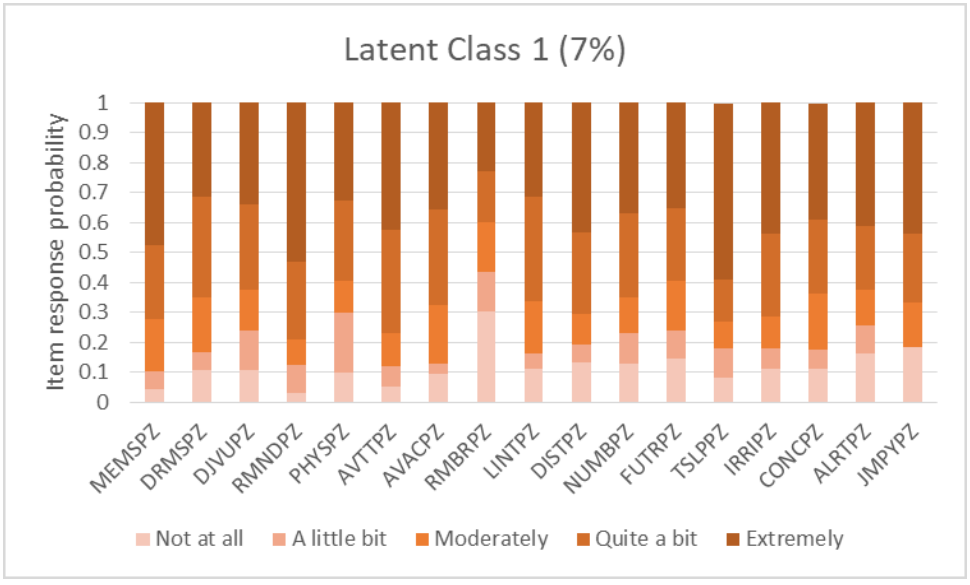


31: Figure – Low PTSD severity class using ordinal PCL-C responses (3-class LCA)

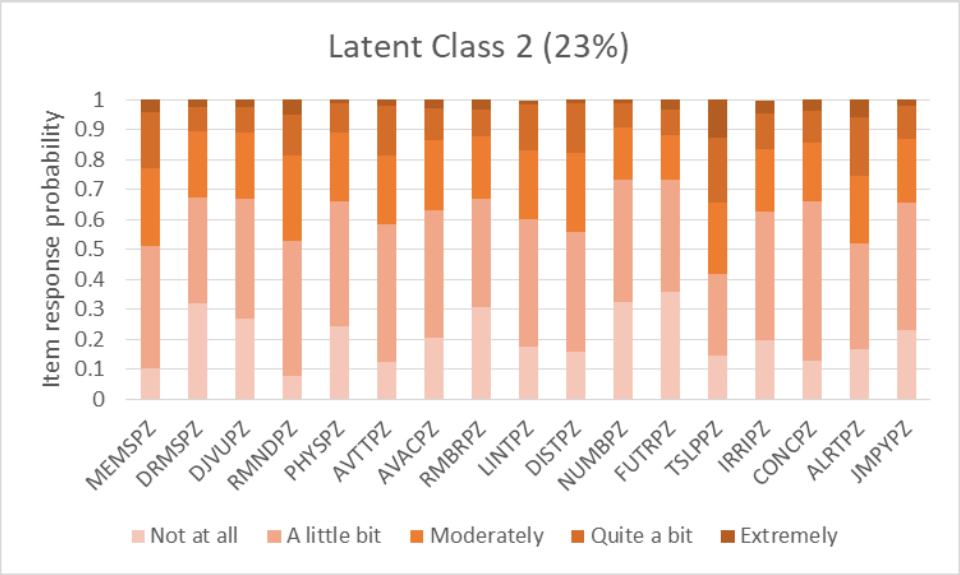


The stacked bar charts shown above depict the item response probabilities for each PCL-C item (corresponding to a symptom) using data. As in the LCAs using binary data, the patterns in item-response probability indicate a low severity group with the highest proportion of participants (49%); a medium severity group with 36% of participants, and a high severity group with 15% of participants.

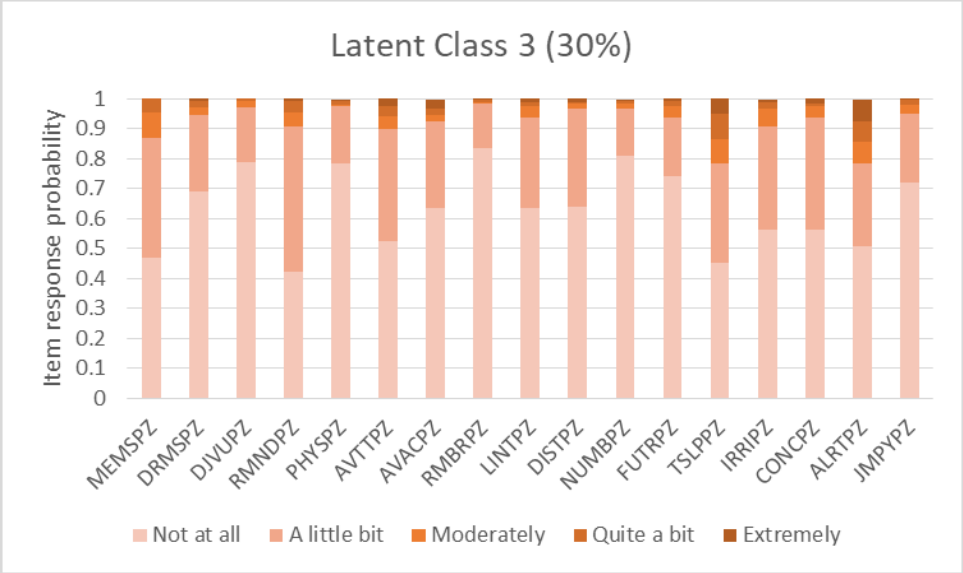
32: Figure – Highest PTSD severity class using ordinal PCL-C responses (4-class LCA)



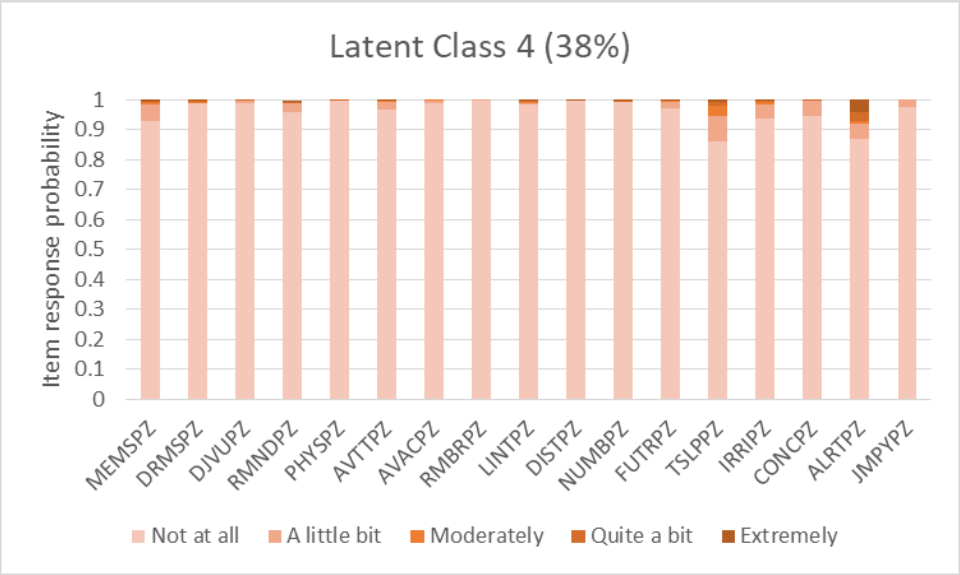
33: Figure – Medium PTSD severity class using ordinal PCL-C responses (4-class LCA)



34: Figure – Low PTSD severity class using ordinal PCL-C responses (4-class LCA)



35: Figure – No PTSD class using ordinal PCL-C responses (4-class LCA)



Using ordinal data, the latent classes are as follows: 7% of participants have probable membership in the highest severity latent class; 23% have latent class membership in a class with lower severity, 30% have almost no disturbance with the majority of participants reporting "not at all" for most symptoms; and finally, a class of 38% with almost no disturbance reported. There does not appear to be a qualitative difference between classes 1 and 2, but rather a similar pattern of endorsement probability differing only in severity.

Appendix 3: Examples of Women's Interagency HIV Study interview guides

WOMEN'S INTERAGENCY HIV STUDY
FORM 21: SOCIODEMOGRAPHICS

SECTION A: GENERAL INFORMATION

A1.	PARTICIPANT ID: ENTER NUMBER HERE ONLY IF ID LABEL IS NOT AVAILABLE	|___|-|___|___| - |___|___|___|___|___| - |___|
A2.	WIHS STUDY VISIT #:	__ __
A3.	FORM VERSION:	**1 0 / 0 1 / 0 8**
A4.	DATE OF INTERVIEW:	__ __ / __ __ / __ __ (M / D / Y)
A5.	INTERVIEWER'S INITIALS:	__ __ __
A6.	DATE OF LAST STUDY VISIT (FROM VISIT CONTROL SHEET)	__ __ / __ __ / __ __ (M / D / Y)
A7.	TIME MODULE BEGAN:	|_|_| : |_|_| AM.....1 PM.....2

INTRODUCTION TO PARTICIPANT:
As we have at prior visits, I will need to ask you numerous questions about your life. I understand that some of these questions may be difficult for you to answer, and exact dates may be hard to remember. Please take as much time as you need so I can gather information which is as accurate as possible. I would also like to remind you that all of your responses will be strictly confidential.

During this first section, I will ask you some questions about your background and income.

PROMPT: IF EVEN NUMBERED VISIT (#2, #4, #6, etc.) SKIP TO B3

B1. **HAND PARTICIPANT RESPONSE CARD 5.**
Choose the answer that best applies to you now from the list I am going to read to you. Are you now...

Legally married/Common-law married 1
Not Married, but living with a partner.....2
Widowed.....3
Divorced/or marriage annulled.....4
Separated 5
Never married 6
Other 7

WIHS ID #

B3. **HAND PARTICIPANT RESPONSE CARD 6.**
Where are you living now?

In your own house/ apartment	1	
At your parent's house	2	
Someone else's house/ apartment	3	
In a rooming, boarding, or halfway house	4	
In a shelter/ welfare hotel	5	
On the street(s) (beach)	6	
Jail/ other correctional facility	7	**(B7 if ODD; B9 if EVEN)**
Residential drug, alcohol treatment facility	8	
Other place	9	

IF LIVING "ON THE STREET(S)/BEACH", REFER TO SOCIAL SERVICE PROVIDER.

B6. Are you currently employed (for pay, full-time or part-time)?

YES 1
NO 2

PROMPT: IF EVEN NUMBERED VISIT (#2, #4, #6, etc.) SKIP TO B9

PROMPT: IN QUESTION B7, PLEASE SUBSTITUTE THE APPROPRIATE TERM WHEN YOU ENCOUNTER "(CURRENT / MOST RECENT)" OR "(LIVE / LIVED)." IF THE RESPONSE TO QUESTION B3 IS 1, 2, 3 OR 9, READ "current" AND "live." IF THE RESPONSE TO QUESTION B3 IS 4, 5, 6, 7 OR 8, READ "most recent" AND "lived."

B7. **HAND PARTICIPANT RESPONSE CARD 7.**
What is or was the average monthly income, before taxes, of your (CURRENT / MOST RECENT) household. Your household includes family members or other people who (LIVE / LIVED) with you and depend on that money. Include pay or money from all sources such as wages, salaries, tips, Social Security, Aid for Dependent Children (AFDC), pension or retirement, and any other kind of support – legal or illegal. **(DO NOT READ ALL RESPONSE CHOICES. CIRCLE THE CODE FOR THE CATEGORY THAT MOST CLOSELY FITS THE RESPONSE GIVEN BY THE PARTICIPANT)**

YEAR	MONTH	WEEK
$6,000 OR LESS 1	$500 OR LESS 1	$115 OR LESS 1
$6,001 TO $12,000 2	$501 TO $1,000 2	$116 TO $231 2
$12,001 TO $18,000 3	$1,001 TO $1,500 3	$232 TO $346 3
$18,001 TO $24,000 4	$1,501 TO $2,000 4	$347 TO $461 4
$24,001 TO $30,000 5	$2,001 TO $2,500 5	$462 TO $577 5
$30,001 TO $36,000 6	$2,501 TO $3,000 6	$578 TO $692 6
$36,001 TO $75,000 7	$3,001 TO $6,250 7	$693 TO $1,442 7
MORE THAN $75,000 8	MORE THAN $6,250 8	MORE THAN $1,442 8

IF PARTICIPANT HAS NO INCOME AT ALL, REFER TO SOCIAL SERVICE PROVIDER

WIHS ID #

INTRODUCTION TO PARTICIPANT:
I am now going to ask you some questions regarding incarceration. Obtaining medications while being incarcerated can be a real problem. The WIHS is trying to learn how incarceration has impacted taking antiretroviral medications for the women in our study. I understand that these questions can sometimes be embarrassing or difficult to answer, but please remember that no one is judging you on your answers. Let me remind you that any answers you give me will have no effect on the care you receive, and all of your answers are personal and confidential, meaning that your name is not associated with your answers. Do you have any questions before we go on?

B9. Since your (MONTH) study visit, have you been incarcerated (spent time in prison or jail)?

YES 1
NO ..... 2 **(B16)**

a. How many times? |__|__|

START F21s1

INTERVIEWER: For each instance of incarceration since the participant's (MONTH) study visit, ask subquestions b and c.

b. For how long?				c. Did you continue taking your antiretroviral medications while you were incarcerated?		
	DAYS	MONTHS	YEARS	YES	NO	N/A
i. |__|__|	1	2	3	1	2	3
ii. |__|__|	1	2	3	1	2	3
iii. |__|__|	1	2	3	1	2	3

END F21s1

B16. TIME MODULE ENDED: |__|__| : |__|__| AM 1
PM 2

WOMEN'S INTERAGENCY HIV STUDY
CIVILIAN POST-TRAUMATIC STRESS DISORDER QUESTIONNAIRE (PTSD)

SECTION A: GENERAL INFORMATION

A1. PARTICIPANT ID: ENTER NUMBER HERE ONLY IF ID LABEL IS NOT AVAILABLE |___|-|___|___|-|___|___|___|___|-|___|

A2. WIHS STUDY VISIT #: ___ ___

A3. FORM VERSION: **1 0 / 0 1 / 0 8**

A4. DATE OF INTERVIEW: ___ ___ / ___ ___ / ___ ___ (M / D / Y)

A5. INTERVIEWER'S INITIALS: ___ ___ ___

A6. DATE OF LAST STUDY VISIT (FROM VISIT CONTROL SHEET) ___ ___ / ___ ___ / ___ ___ (M / D / Y)

A7. TIME MODULE BEGAN: |_|_| : |_|_| AM .....1 PM 2

SECTION B: QUESTIONNAIRE

INTRODUCTION TO PARTICIPANT: I will read you a list of problems and complaints that people sometimes have in response to stressful experiences. Please tell me the appropriate response to indicate how much you have been bothered by that problem in the past month.

PROMPT: HAND PARTICIPANT FOLLOW-UP RESPONSE CARD P1.

B1. Over the *past month*, how frequently have you been bothered by…

	Not at all	A little bit	Moderately	Quite a bit	Extremely
a. Repeated, disturbing memories, thoughts, or images of a stressful experience	1	2	3	4	5
b. Repeated, disturbing dreams of a stressful experience	1	2	3	4	5
c. Suddenly acting or feeling as if a stressful experience were happening again (as if you were reliving it)	1	2	3	4	5
d. Feeling very upset when something reminded you of a stressful experience.....	1	2	3	4	5
e. Having physical reactions (e.g., heart pounding, trouble breathing, sweating) when something reminded you of a stressful experience.....	1	2	3	4	5

WIHSID

	Not at all	A little bit	Moderately	Quite a bit	Extremely
f. Avoiding thinking about or talking about a stressful experience or avoiding having feelings related to it	1	2	3	4	5
g. Avoiding activities or situations because they reminded you of a stressful experience	1	2	3	4	5
h. Trouble remembering important parts of a stressful experience	1	2	3	4	5
i. Loss of interest in activities that you used to enjoy	1	2	3	4	5
j. Feeling distant or cut off from other people	1	2	3	4	5
k. Feeling emotionally numb or being unable to have loving feelings for those close to you	1	2	3	4	5
l. Feeling as if your future will somehow be cut short	1	2	3	4	5
m. Trouble falling or staying asleep	1	2	3	4	5
n. Feeling irritable or having angry outbursts	1	2	3	4	5
o. Having difficulty concentrating	1	2	3	4	5
p. Being "super-alert" or watchful or on guard	1	2	3	4	5
q. Feeling jumpy or easily startled	1	2	3	4	5

PROMPT: HAND PARTICIPANT FOLLOW-UP RESPONSE CARD P2.

B2. Over the *past month*, how frequently have you…

	Never	Almost never	Sometimes	Fairly often	Very often
a. Been upset because of something that happened unexpectedly	1	2	3	4	5
b. Felt that you were unable to control the important things in your life	1	2	3	4	5

WIHSID

	Never	Almost never	Sometimes	Fairly often	Very often
c. Felt nervous and "stressed"	1	2	3	4	5
d. Felt confident about your ability to handle your personal problems	1	2	3	4	5
e. Felt that things were going your way	1	2	3	4	5
f. Found that you could not cope with all the things that you had to do	1	2	3	4	5
g. Been able to control irritations in your life	1	2	3	4	5
h. Felt that you were on top of things	1	2	3	4	5
i. Been angered because of things that were outside of your control	1	2	3	4	5
j. Felt difficulties were piling up so high that you could not overcome them	1	2	3	4	5

B2. TIME MODULE ENDED |__|__| : |__|__| AM..... 1
PM..... 2

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Wolf, E. J., & Schnurr, P. P. (2016). Developing Comprehensive Models of the Effects of Stress and Trauma on Biology, Brain, Behavior, and Body. *Biological Psychiatry*, *80*(1), 6–8. https://doi.org/10.1016/j.biopsych.2016.04.016

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Wyatt, G. E., Hamilton, A. B., Myers, H. F., Ullman, J. B., Chin, D., Sumner, L. A., … Liu, H. (2011). Violence prevention among HIV-positive women with histories of violence: Healing women in their communities. *Women's Health Issues*, *21*(6 SUPPL.), S255–S260. https://doi.org/10.1016/j.whi.2011.07.007

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Wyka, K. (2013). The application of latent class analysis and latent transition analysis to large scale disaster data: Modeling PTSD in a population of disaster workers. *Dissertation Abstracts International: Section B: The Sciences and Engineering*, *74*(6–B(E)), No-Specified. Retrieved from http://gateway.proquest.com/openurl?url_ver=Z39.88-2004&rft_val_fmt=info:ofi/fmt:kev:mtx:dissertation&res_dat=xri:pqm&rft_dat=xri:pqdiss:3553584%5Cnhttp://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=psyc10&NEWS=N&AN=2013-99241-024

CV

Mar 2018

CURRICULUM VITAE

KRITI MUNJAL JAIN

PERSONAL DATA

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EDUCATION AND TRAINING

Education:

2015-18 PhD, Bloomberg School of Public Health
Johns Hopkins University
Health, Behavior, and Society (Quantitative)

2009-11 MSPH, Bloomberg School of Public Health
Johns Hopkins University
Concentration: Disease Epidemiology and Control;
Mixed Methods

2003-7 SB, Massachusetts Institute of Technology
Major: Microbiology
Concentration: Economics

PROFESSIONAL EXPERIENCE

2/1/18-	Social Science Research Analyst (Contract) Office of Planning, Research, and Evaluation Administration for Children and Families
8/1/15-	Independent Evaluation Consultant Clients include AIDS United, Medical Advocacy and Outreach
9/1/13 to 1/1/17	Evaluation and Research Manager, Department of Health, Behavior & Society, Johns Hopkins Bloomberg School of Public Health Duties: Lead mixed methods case studies for 17 Access to Care sites, and managed a portfolio of 12 evaluations that included clinical and survey-based outcomes.
6/1/11 to 9/1/13	Research Consultant and Associate Technical Advisor, Population Services International Duties: Designed, built, and trained country staff on monitoring and evaluation system; led donor reporting for 15 country, $90 million reproductive health project.
6/1/2010 to 9/1/10	Graduate Research Intern Reproductive Health Department PATH Duties: Analyzed survey and surveillance data on adverse events following HPV immunization from three HPV demonstration project countries.
9/1/2007 to 12/1/08	Market Researcher and Data Analyst ZS Associates Duties: Analyzed large drug sales and insurance datasets; collected qualitative and quantitative data; presented findings to clients.
6/1/2006 to 8/31/2006	MIT Washington DC Program Intern Office of Global Research National Institute of Allergy and Infectious Disease National Institutes of Health Duties: conducted and presented analyses of NIH investments in individual countries

PROFESSIONAL ACTIVITIES

Peer Review Activities:

AIDS and Behavior
AIDS and Behavior, Consulting Editorial Board 2017
AIDS Care
BMC Infectious Diseases
International Journal of STD & AIDS
Journal of AIDS & Clinical Research
Journal of Behavioral Medicine
National HIV Prevention Conference 2015
Scientific Reports (Nature Publishing Group)

HONORS AND AWARDS

HBS Distinguished Doctoral Research Award, Department of Health, Behavior, and Society, 2017-2018.
William Haddon Jr. Fellowship (Co-recipient), Department of Health Policy and Management, 2017-2018.
Susan Baker Scholarship in Injury Prevention, Department of Health Policy and Management, 2017-2018.
HBS Distinguished Doctoral Research Award, Department of Health, Behavior, and Society, 2016-2017.
Departmental Special Project Funding Award, Department of Health, Behavior, and Society, 2015-2016.
STI Training Program (T32), Johns Hopkins Bloomberg School of Public Health, 2015-2016.
Leadership Fund Recipient, Katie Evans Memorial Scholarship, 2011
New Investigator in Global Health, Global Health Council Conference, 2011
Global Health Scholarship (100% merit scholarship for MSPH), Department of International Health, Johns Hopkins Bloomberg School of Public Health, 2009-2010
Kelly-Douglas Fund Grant Recipient, Massachusetts Institute of Technology, 2007
Public Service Center Grant Recipient, Massachusetts Institute of Technology, 2007
Dana Mead Scholar, Massachusetts Institute of Technology, 2006

PUBLICATIONS

Journal Articles and Other Peer-Reviewed Publications:

1. **Jain KM**, Crossnohere N, Davey-Rothwell M, Latkin C. Post-traumatic Stress Disorder, Neighborhood Satisfaction, and Social Network Characteristics among Underserved Women living in Baltimore, MD. *In press.*

2. Maulsby C, **Jain KM**, Weir BW, The RiC Intervention Team, Enobun B, Werner M, Riordan M, Holtgrave, DR. Cost-Utility of Access to Care, a National HIV Linkage, Re-engagement, and Retention in Care Program. AIDS and Behavior. 2018 Jan 4. doi: 10.1007/s10461-017-2015-z. [Epub ahead of print]

3. **Jain KM**, Bhat P, Maulsby C, Andersen A, Soto T, Holtgrave DR, Dill L. Extending access to care across the rural U.S. south: preliminary results from Alabama eHealth, an innovative telemedicine program. Journal of Telemedicine and Telecare. *In press.*

4. Maulsby C, Sacamano P, **Jain KM**, Enobun B, Brantley M, Kim HY, Riordan M, Werner M, The A2C Implementation Team, Holtgrave DR. Barriers and Facilitators to the Implementation of a National HIV Linkage, Re-engagement and Retention in Care program. AIDS Education and Prevention. 2017 Oct;29(5):443-456.

5. Maulsby C, Enobun B, Batey DS, **Jain KM,** Access to Care Intervention Team, Riordan M, Werner M, Holtgrave DR. A Mixed-Methods Exploration of the Needs of People Living with HIV (PLWH) Enrolled in Access to Care, a National HIV Linkage, Retention, and Re-Engagement in Medical Care Program. AIDS and Behavior. 2017 May 26. doi: 10.1007/s10461-017-1809-3.

6. Maulsby C, **Jain KM**, Weir BW, Enobun B, Riordan M, Charles VE, Team RI, Holtgrave DR. The Cost and Threshold Analysis of Retention in Care (RiC): A Multi-Site National HIV Care Program. AIDS and Behavior. 2016 Nov 21:1-7.

7. Maulsby C, Valdiserri RO, Kim JJ, Mahon N, Flynn A, Eriksson E, **Jain KM**, Enobun B, Holtgrave DR. The Global Engagement in Care Convening: Recommended Actions to Improve Health Outcomes for People Living With HIV. AIDS Education and Prevention. 2016 Oct;28(5):405-16.

8. **Jain KM**, Maulsby C, Kinsky S, Khosla N, Charles V, Riordan M, Holtgrave DR. Exploring Changes in Interagency Collaboration Following AIDS United's Positive Charge A Five-Site HIV Linkage and Retention in Care Program. Health Education & Behavior. 2016 Dec 1;43(6):674-82.

9. **Jain KM**, Maulsby C, Brantley M, Kim JJ, Zulliger R, Riordan M, Charles V, Holtgrave DR. Cost and cost threshold analyses for 12 innovative US HIV linkage and retention in care programs. AIDS care. 2016 Sep 1;28(9):1199-204.

10. **Jain KM,** Maulsby C, Kinsky S, Charles V, Holtgrave DR. 2015–2020 National HIV/AIDS Strategy Goals for HIV Linkage and Retention in Care: Recommendations From Program Implementers. American Journal of Public Health. 2016 March; 106(3):399-401.

11. **Jain KM**, Zulliger R, Maulsby C, Kim JJ, Charles V, Riordan M, Holtgrave D. Cost-Utility Analysis of Three US HIV Linkage and Re-engagement in Care Programs from Positive Charge. AIDS and Behavior. 2016 May 1;20(5):973-6.

12. Kinsky S, Maulsby CH, **Jain KM**, Charles V, Riordan M, Holtgrave DR. Barriers and facilitators to implementing access to HIV care interventions: a qualitative analysis of the Positive Charge initiative. AIDS Education and Prevention. 2016 Oct;27(5):391-404.

13. Maulsby C, Kinsky S, **Jain KM**, PC Intervention Team, Holtgrave, D.R. Unpacking linkage and re-engagement in care: A day in the life of a linkage to care coordinator. AIDS Education and Prevention. 2016 Oct. 27(5):405-417.

14. Kim JJ, Maulsby C, Zulliger R, **Jain K**, Charles V, Riordan M, Davey-Rothwell M, Holtgrave DR. Cost and threshold analysis of Positive Charge, a multi-site linkage to HIV care program in the United States. AIDS and Behavior. 2015 Oct 1;19(10):1735-41.

15. Maulsby C, Charles V, Kinsky S, Riordan M, **Jain K**, Holtgrave D. Positive charge: filling the gaps in the US HIV continuum of care. AIDS and Behavior. 2015 Nov 1;19(11):2097-107.

16. Kim JJ, Maulsby C, Kinsky S, Riordan M, Charles V, **Jain K**, Holtgrave DR. The development and implementation of the national evaluation strategy of access to care, a multi-site linkage to care initiative in the United States. AIDS Education and Prevention. 2014 Oct;26(5):429-44.

17. Maulsby C, **Jain K**, Sifakis F, German D, Flynn CP, Holtgrave D. Individual-Level and Partner-Level Predictors of Newly Diagnosed HIV Infection Among Black and White Men Who Have Sex with Men in Baltimore, MD. AIDS and Behavior. 2015 May 1;19(5):909-17.

18. Keller B, Labrique A, **Jain KM**, Pekosz A, Levine O. Mind the gap: social media engagement by public health researchers. Journal of Medical Internet Research. 2014;16(1):e8.

19. Blumenthal P, Shah N, **Jain KM**, Saunders A, Clemente C, Lucas B, Jafa K, and Eber M. Revitalizing long-acting reversible contraceptives in settings with high unmet need: a multi-country experience matching demand creation and service delivery. Contraception. 2010 Aug 1;82(2):188.

20. **Jain KM**, Paul P, LaMontagne DS. Monitoring adverse events following immunisation in developing countries: experience from human papillomavirus vaccination demonstration projects. Sexual health. 2013 Mar 8;10(1):57-63.

Books (Peer-Reviewed):

Jain KM, Holtgrave DR, Maulsby C, Kim JJ, Zulliger R, Massey M, Charles V. Improving access to HIV care: Lessons from five US sites. JHU Press; 2015 Dec 16.

Articles in Progress:

1. Woznica DM, Mabuto T, Charalambous S, Owczarzak JT, **Jain KM**, Hoffman CJ. South African ex-offenders' experiences of linkage to HIV care and retention post-release. (Submitted)

2. **Jain KM**, Mshweshwe-Pakela N, Mabuto T, Hoffmann CJ. "If I take my treatment … I will live a long life": A qualitative exploration of Thol'impilo, a randomized linkage to care intervention in South Africa. (Submitted)

3. **Jain KM,** Nguyen T, Park J, Campbell J**,** Adedimeji A, Benning L, Cohen J, Merenstein D, Weber K, Wilson T, German D. Posttraumatic stress symptom latent classes and their correlates among U.S. women living with HIV. (Internal review)

4. Eban II cost analysis (Internal review).

5. Park JN, Bass JK, Xue QL, **Jain KM**, Decker MR, Galai N, Footer K, and Sherman SG. Posttraumatic Stress Disorder among urban street-based female sex workers: Comorbidities, cluster patterns and factor structure.

6. **Jain KM,** Marcell AV, Billioux V, Dittus P, Loosier PS, Jennings J. Cost-savings and cost-effectiveness thresholds of a Sexual and Reproductive Health program focused on young minority males (Internal review)

7. **Jain KM,** Nguyen T, Campbell J**,** Adedimeji A, Benning L, Cohen J, Merenstein D, Weber K, Wilson T, German D. Posttraumatic stress symptom levels and their relationship to HIV care outcomes and behaviors. (Internal review)

8. **Jain KM,** Nguyen T, Moen M, Campbell J**,** Adedimeji A, Benning L, Cohen J, Merenstein D, Weber K, Wilson T, German D. PTSD latent class transitions and their predictors. (Internal review)

KRITI M. JAIN

PART II

TEACHING

Teaching Assistantships
Translating Research into Public Health Policy, 2017 (2 terms), Prof. David Holtgrave and Dr. Brian Weir
Translating Research into Public Health Policy, 2016 (2 terms), Prof. David Holtgrave and Dr. Brian Weir
Global Disease Epidemiology and Control Seminar (4 terms), 2010-2011, Ms. Karen Charron
Global Disease Control Programs and Policies, 2011, Dr. Christian Coles and Dr. Alain Labrique

RESEARCH GRANT PARTICIPATION

Training Grants:

"STI Training Grant for Predoctoral Fellows (T32)," National Institutes of Health. Role: Trainee. Project period: September 1, 2015-August 31, 2016. Total amount: $39,920.

PRESENTATIONS

Scientific Meetings -- Presented Posters and Published Abstracts:

Enobun B, Maulsby C, **Jain KM**, Riordan M, Werner M, Holtgrave DR. Gender and racial differences in social distancing stigma experienced by PLWH. Poster presentation at 2016 Stigma conference. Washington, DC.

Jain KM, Latkin C, Davey-Rothwell M. Post-Traumatic Stress Disorder, Neighborhood Satisfaction, and Social Network Characteristics among Women at Risk for HIV/Sexually Transmitted Infections (STI). Oral presentation at ICOWHI 2016. Baltimore, MD.

Jain KM, Heuklom S, Marcell AV, Hager C, Jennings JM. Economic Analysis of a Community-Based Intervention to Increase Sexual and Reproductive Health Care among Young Males aged 15-24. 2016 STD Prevention Conference. Atlanta, GA.

Jain KM, Bhat P, Maulsby C, Andersen A, Soto T, Holtgrave D, Riordan M, Werner M, Dill L. Extending access to care across the rural U.S. south: Steps to initiating Alabama eHealth, an innovative telemedicine program. Roundtable presentation at the annual American Public Health Association Conference. Denver, CO.

Jain KM, Bhat P, Maulsby C, Andersen A, Soto T, Holtgrave D, Riordan M, Werner M, Dill L. "They think it's like Star Trek": Barriers and facilitators to implementing Alabama

eHealth, an innovative telemedicine program. Roundtable presentation at the annual American Public Health Association Conference. Denver, CO.

Enobun B, Maulsby C, **Jain KM**, Werner M, Riordan M, Holtgrave D. Meeting the needs of PLWH to promote linkage and retention in HIV care: Findings, strategies and lessons learned from Access to Care. Oral presentation at the annual American Public Health Association Conference. Denver, CO.

Enobun B, **Jain KM**, Maulsby C, Riordan M, Werner M. The RiC Intervention Team, Holtgrave, D. June 10, 2016. Evaluating the Impact of Retention in HIV Care: Findings from RiC, a retention in care program. Poster presentation at the Center for AIDS Research Annual Meeting. Baltimore, MD.

Jain KM, Latkin C, Davey-Rothwell, M. May 26, 2016. Post-Traumatic Stress Disorder, Neighborhood Satisfaction, and Social Network Characteristics among Women at Risk for HIV/Sexually Transmitted Infections (STI). Poster presentation at the 9th Annual Women's Health Research Symposium. Baltimore, MD.

Reilly M, **Jain KM**, Maulsby C, Riordan M, SIF Implementation Team, Holtgrave DR. December 14, 2015. Economic evaluation of eleven linkage and retention in HIV care programs across the United States. Poster presentation at the 8th Annual Conference on the Science of Dissemination and Implementation. Washington, DC.

Jain KM, Maulsby C, Kinsky S, Khosla N, Charles VE, Riordan M, Nortrup E, Holtgrave DR. November 2, 2015. Exploring changes in interagency collaboration following Positive Charge, a five site HIV linkage and retention in care program. Oral presentation at American Public Health Association Conference 2015. Chicago, IL.

Enobun B, **Jain, KM**, Maulsby C, Kinsky S, Riordan M, PC intervention Team, Nortrup E, Holtgrave DR. November 1, 2015. Improving access to HIV care through the Positive Charge Intervention: Lessons learned from five U.S. cities. Poster presented at American Public Health Association Conference 2015. Chicago, IL.

Maulsby C, **Jain KM**, Enobun B, Holtgrave DR. September 10-13, 2015. Evaluation of AIDS United Retention in Care (RiC) Initiative. Panel presentation at United States Conference on AIDS 2015. Washington, DC.

Jain KM, Reilly M, Nortrup E, Riordan M, Holtgrave DR. September 10-13, 2015. Social distancing stigma experienced by participants in 12 U.S. HIV linkage to care programs. Poster presented at United States Conference on AIDS 2015. Washington, DC.

Kinsky S, Maulsby C, **Jain KM**, PC Intervention Team, Holtgrave DR. July 17-18, 2015. Implementing Access to Care Interventions: Structural, Organizational, and Personnel Barriers and Facilitators. Poster presented at International AIDS Society 2015. Vancouver, CA.

Maulsby C, **Jain KM**, Reilly M, Charles V, Kinsky S, Adams A, RiC Intervention Team, Holtgrave, D.R. October 2-5, 2014. Innovative strategies to keep vulnerable populations in HIV care: An overview of RiC, a retention in care program. Poster presented at United States Conference on AIDS 2014. San Diego, CA.

Jain KM, Paul P, LaMontagne DS. June 13-17, 2011. Monitoring adverse events following immunization in developing countries. Poster presented at Global Health Council 2011 Conference, Washington DC.

Invited talks

Jain KM. "They think it's like Star Trek": Set up and initial patient outcomes in the innovative Alabama ehealth telemedicine program. Webcast 2017.

ADDITIONAL INFORMATION

Major, Current Research Interests:

linkage to HIV care and treatment, HIV, psychological trauma, post-traumatic stress disorder (PTSD), STI/HIV risk behavior, social determinants of health, economic evaluation of public health programs and policies

Continued Training:

CITI Course in the Protection of Human Research Subjects
Johns Hopkins University Course in Blood Borne Pathogens
Johns Hopkins University Course in HIPAA for Research
Johns Hopkins University Course in Preventing Sexual Harassment
Johns Hopkins University Course in Preventing Discrimination
Johns Hopkins Bloomberg School of Public Health Course in Academic Ethics

Keywords:

Access to Care, Equity, Economic Evaluation of Chronic Disease Programs and Policies, Linkage to Care, Interorganizational Collaboration, Retention in Care, Post-Traumatic Stress Disorder (PTSD), Trauma, Social Determinants of Health, Health Disparities, Economic Evaluation